INSTALLATION RESTORATION PROGRAM (IRP) PRELIMINARY ASSESSMENT OF THE 154th AIR CONTROL SQUADRON

154th AIR CONTROL SQUADRON
KEKAHA ARMORY
HAWAII AIR NATIONAL GUARD
KEKAHA, KAUAI, HAWAII

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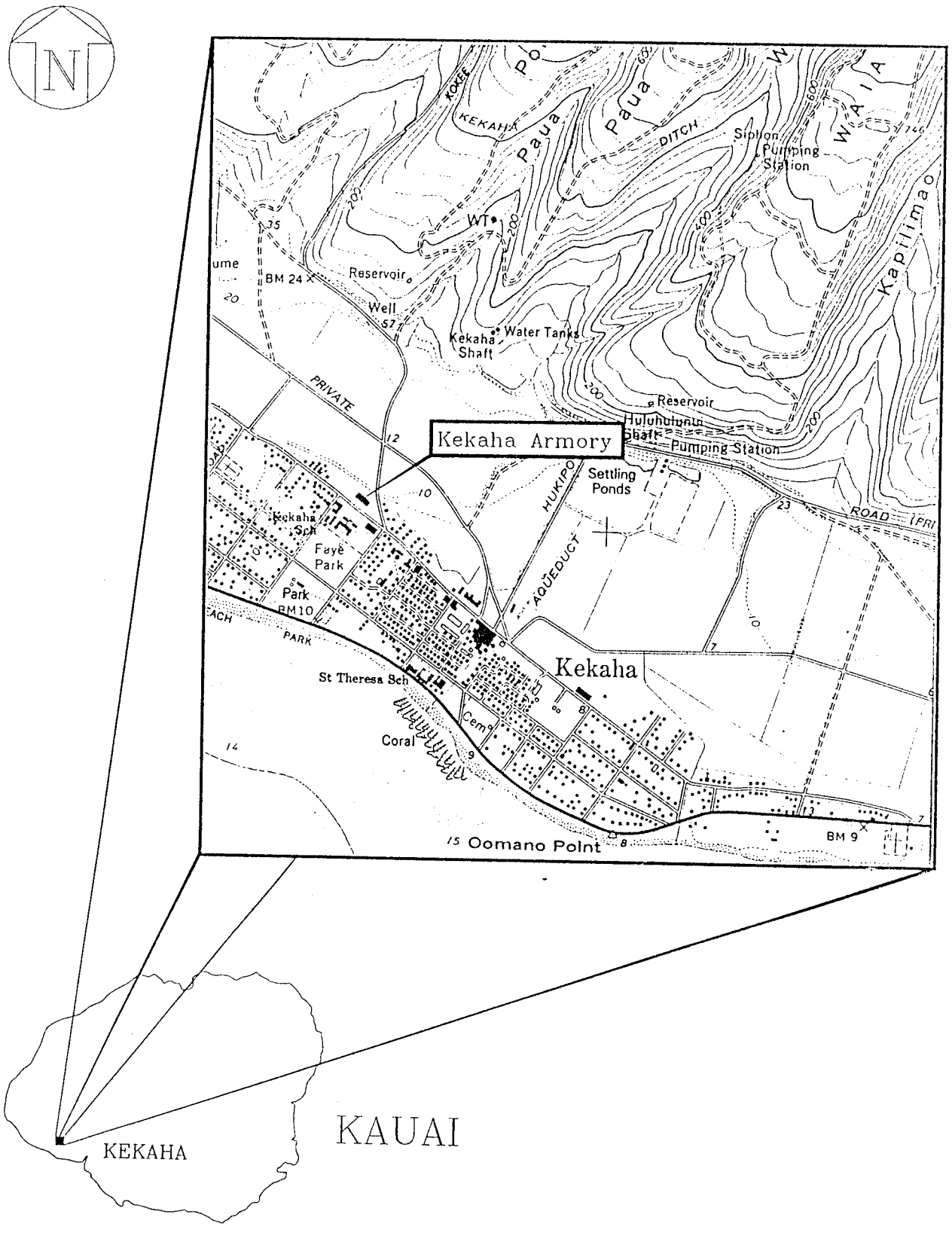

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SOURCE: USGS 7.5' TOPOGRAPHIC MAP, KEKAHA, HAWAII, 1983.

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R\KEKAHA\SITE

INSTALLATION LOCATION MAP
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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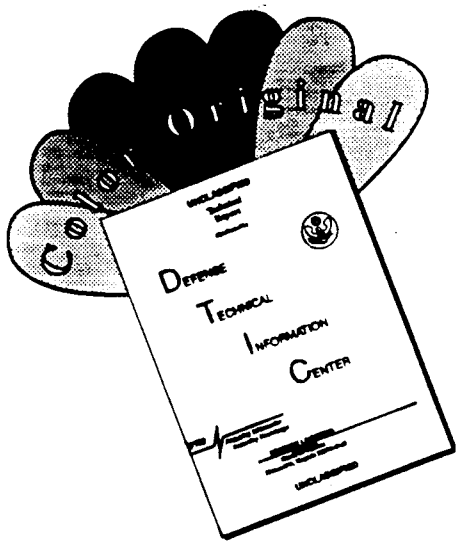

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13. ABSTRACT *(Maximum 200 words)*

The document identifies ANGRC attempt to assess possible Installation Restoration Program sites at the station. The process involves research via personal interviews, record searchs, review historic data, assessing "As Built Drawings", Aerial photographs, and a site visit.

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INSTALLATION RESTORATION PROGRAM (IRP) PRELIMINARY ASSESSMENT OF THE 154th AIR CONTROL SQUADRON

154th AIR CONTROL SQUADRON
KEKAHA ARMORY
HAWAII AIR NATIONAL GUARD
KEKAHA, KAUAI, HAWAII

JANUARY 1995

Prepared For

AIR NATIONAL GUARD READINESS CENTER
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154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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LIST OF ACRONYMS

ACS	Air Control Squadron
AFB	Air Force Base
ANG	Air National Guard
ANGRC/CEVR	Air National Guard Readiness Center Installation Restoration Program Branch
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DQO	Data Quality Objectives
EO	Executive Order
F	Fahrenheit
FFS	Focused Feasibility Study
FS	Feasibility Study
HM/HW	Hazardous Materials/Hazardous Waste
IRP	Installation Restoration Program
MSL	Mean sea level
NPL	National Priorities List
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Investigation
PL	Public Law
PMRF	Pacific Missile Range Facility
ppm	Parts per million
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
R&D	Research and Development
RI	Remedial Investigation
RM	Remedial Measure
SARA	Superfund Amendments and Reauthorization Act of 1986
SCS	Soil Conservation Service
SI	Site Investigation
USEPA	United Station Environmental Protection Agency
USGS	United States Geologic Survey
UST	Underground storage tank
UTA	Unit Training Assembly

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INSTALLATION RESTORATION PROGRAM
PRELIMINARY ASSESSMENT

EXECUTIVE SUMMARY

A. Introduction

The Air National Guard Readiness Center (ANGRC), Installation Restoration Programs Branch (CEVR) has the responsibility for managing the Installation Restoration Program (IRP) on all property the Air National Guard maintains. In April 1994, the Preliminary Assessment (PA) for the Kekaha Armory, Kekaha, Kauai, Hawaii (also referred to as the installation) was initiated by personnel from the ANGRC/CEVR. Operational Technologies Corporation (OpTech) of San Antonio, Texas, was tasked by the ANGRC/CEVR to conduct the PA at the Station. The PA included:

- An on-site visit by ANGRC and OpTech personnel on April 19 and April 20, 1994;
- Interviews with 13 present installation personnel;
- The acquisition and analysis of pertinent information and records on hazardous material use and hazardous waste generation and disposal at the installation;
- The acquisition and analysis of available geologic, hydrologic, meteorologic, and environmental data from pertinent Federal, State, and local agencies; and
- An assessment of the installation to determine if areas of concern (AOCs) exist which may have been contaminated with hazardous materials/hazardous wastes (HM/HW).

B. Major Findings

Past activities at Kekaha Armory involved the use and disposal of materials and wastes which could be categorized as hazardous. The major operations of the installation that use and dispose of HM/HW include motor vehicle maintenance, fuels management, corrosion control, and the

paint shop and battery shop. Wastes generated by these activities include waste oils, spent fuels, cleaning solvents, paint wastes, and thinners.

Interviews were conducted with 13 present installation personnel with an average tenure of 20 years at the installation. As a result of interviews and a field survey, no Area of Concern (AOC) at the installation was identified as potentially contaminated with HM/HW.

C. Conclusions

The information obtained through interviews with 13 present installation personnel, review of installation records, and field observations has resulted in the identification of no Areas of Concern at the installation.

D. Recommendations

No further IRP investigation is warranted since no Areas of Concern have been identified.

SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

This Preliminary Assessment (PA) covers the 154th Air Control Squadron (ACS), Hawaii Air National Guard, Kekaha Armory, Kekaha, Kauai. Some operations at the Kekaha Armory over a period of approximately 52 years involved the use and disposal of materials and wastes which could be categorized as hazardous. Consequently, the Air National Guard Readiness Center initiated the Installatlion Restoration Program (IRP) at the Kekaha Armory. Coordination of the IRP at the installation is the responsibility of the 154th Group Environmental Management Office located at Hickam Air Force Base (AFB), Oahu, Hawaii.

1.2 INSTALLATION RESTORATION PROGRAM (IRP)

The IRP is a comprehensive program designed to:

- Identify and fully evaluate suspected problems associated with past hazardous waste disposal and/or spill sites on Department of Defense (DoD) facilities; and

- Control hazards to human health, welfare, and the environment that may have resulted from these past practices.

During June 1980, the DoD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM 80-6) requiring the identification of past hazardous waste disposal sites on DoD installations. The policy was issued in response to the Resource Conservation and Recovery Act (RCRA) of 1976 and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510 of 1980, commonly known as "Superfund." In August 1981, the President delegated certain authority specified under CERCLA to the Secretary of Defense through an Executive Order (EO 12316). As a result of EO 12316, the DoD revised the IRP by issuing DEQPPM 81-5 on 11 December 1981, which reissued and amplified all previous environmental directives and memoranda.

Although the DoD, IRP, and the U.S. Environmental Protection Agency's (USEPA) Superfund Programs were essentially the same, differences in the definition of program activities and lines of authority existed. These differences were rectified with the passage of the Superfund Amendments and Reauthorization Act (SARA, PL-99-499) of 1986. On January 23, 1987, a

Presidential Executive Order (EO 12580) was issued which effectively revoked EO 12316 and implemented the changes promulgated by SARA.

The most important changes put into effect by the SARA legislation include:

- Section 120 of SARA provides that Federal facilities, including those within the DoD, are subject to all provisions of CERCLA/SARA concerning site assessment, evaluation under the National Contingency Plan (40 CFR 300), listing on the National Priorities List (NPL), and removal/remedial actions. The DoD must therefore comply with regulations and criteria promulgated by USEPA under Superfund authority.

- Section 211 of SARA also provides continuing statutory authority for the DoD to conduct its IRP as part of the Defense Environmental Restoration Program (DERP). The statutory authority was emplaced by adding Chapter 160, Sections 2701 - 2707 to Title 10, United States Code (10 USC 160).

- SARA also stipulates that terminology used to describe or to otherwise identify actions carried out under the IRP shall be substantially the same as the terminology of the regulations and guidelines issued by the USEPA under their Superfund authority.

As a result of SARA, the operational activities of the IRP are currently defined and described in the following sections and are illustrated in Figure 1.1.

1.3 PURPOSE

The purpose of this PA under the IRP is to identify and evaluate suspected problems associated with past waste handling procedures, and to identify historic disposal and/or spill sites on Kekaha Armory property.

The potential for migration of hazardous contaminants was evaluated by visiting the installation, reviewing existing environmental data, analyzing records concerning the use and disposal of hazardous materials, and documentation concerning the generation of hazardous wastes. Interviews were conducted with current and past installation personnel who have knowledge of historical waste handling and disposal techniques and practices, and screening of available

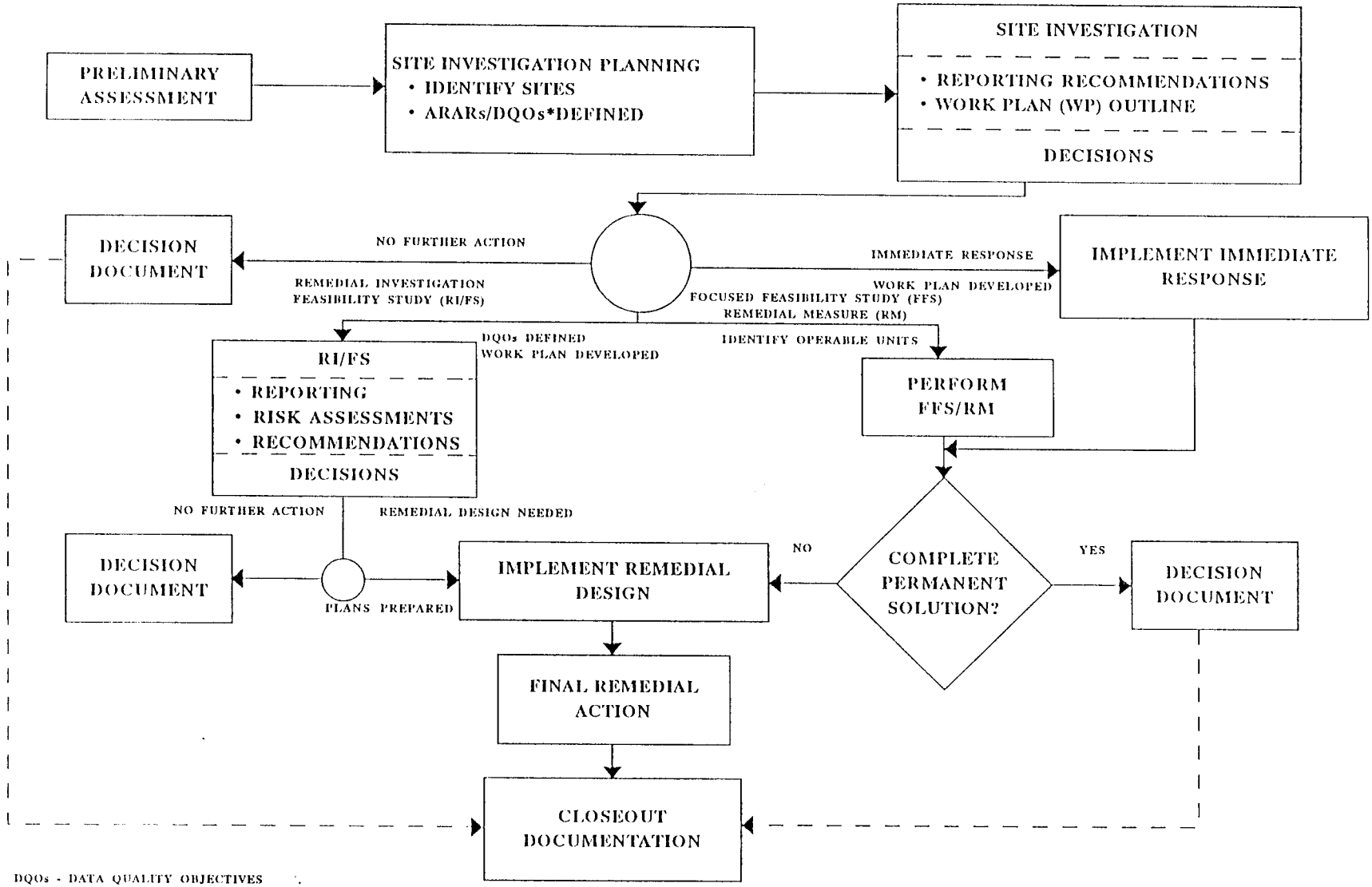

FIGURE 1.1

KEKA\FLODIAG

FLOW OF INSTALLATION RESTORATION PROGRAM TASKS
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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sources was conducted to obtain preliminary data concerning the suspected contamination. Additionally, available information within the public domain was gathered to obtain sufficient data to establish the environmental setting for the local region of the installation.

1.4 SCOPE

The scope of the PA is limited to the identification of property at and under the primary control of the 154th ACS and the evaluation of potential receptors. The PA included:

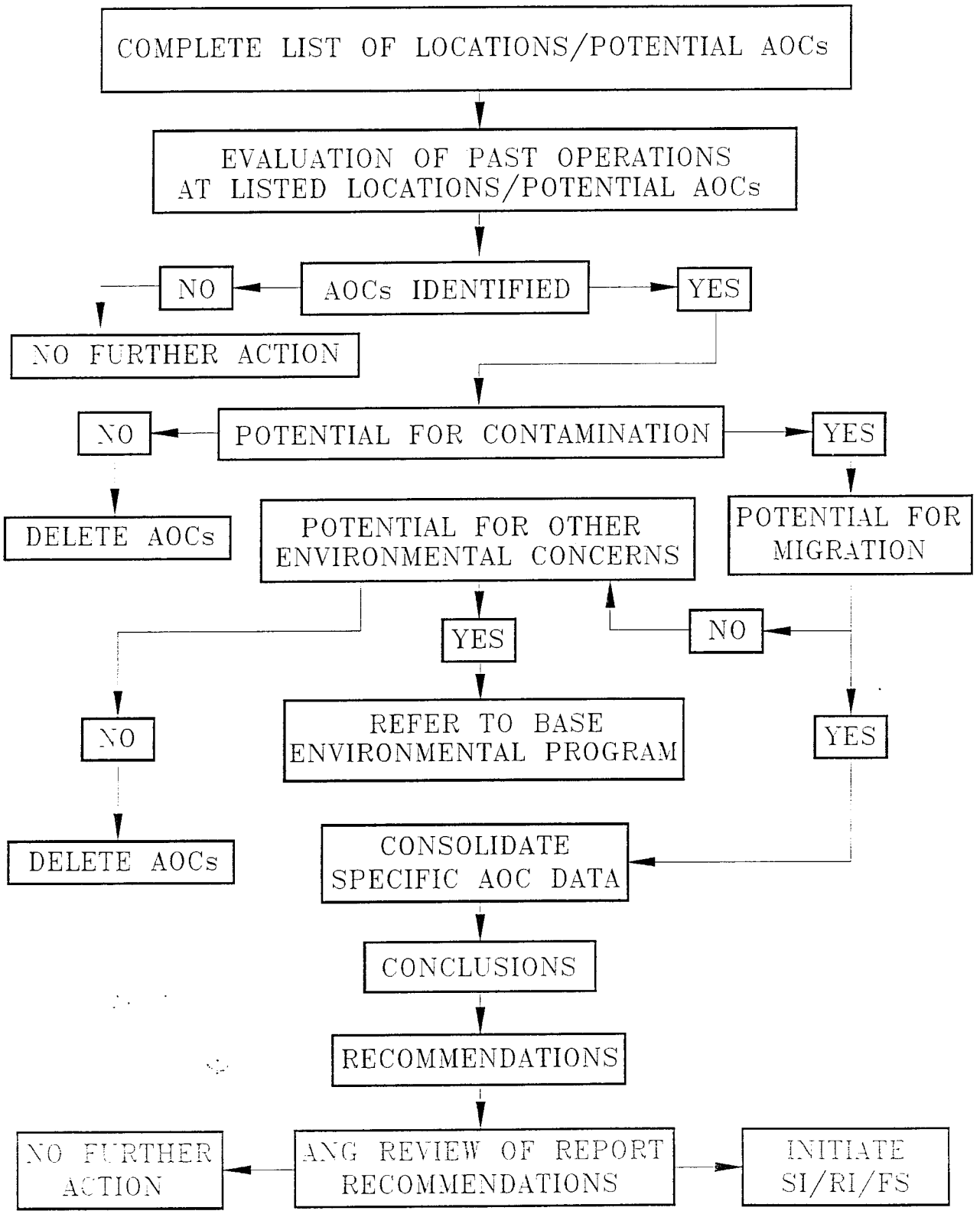
- On-site visits on April 19 and April 20, 1994;
- Interviews with 13 current and former installation personnel, with an average of 20 years' tenure;
- The acquisition of records and information on past and present hazardous materials use, waste handling practices, and waste disposal at Kekaha Armory; and
- The acquisition of available information pertaining to geological, hydrological, meteorological, land use and zoning, critical habitat, and related data from Federal, State, and local agencies.

1.5 METHODOLOGY

The PA began with an ANGRC inbriefing with key Hawaii Air National Guard leaders to explain the purpose of the PA and to solicit their support during the information gathering phases. Questionnaires were distributed to personnel of mission support operations in order that they could list estimated quantities of hazardous materials/hazardous wastes (HM/HW) historically used in their shops and methods of HM/HW disposal. The overall PA methodology is depicted in Figure 1.2.

Detailed geological, hydrological, meteorological, and population, land use, and environmental data for the area surrounding Kekaha Armory were obtained from appropriate Federal, State, and local agencies. A listing of outside agencies contacted is included in Appendix A.

DECISION TREE



SOURCE: ANGRC/CEVR, 1993.

FIGURE 1.2

PRELIMINARY ASSESSMENT METHODOLOGY CHART
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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SECTION 2.0 INSTALLATION DESCRIPTION

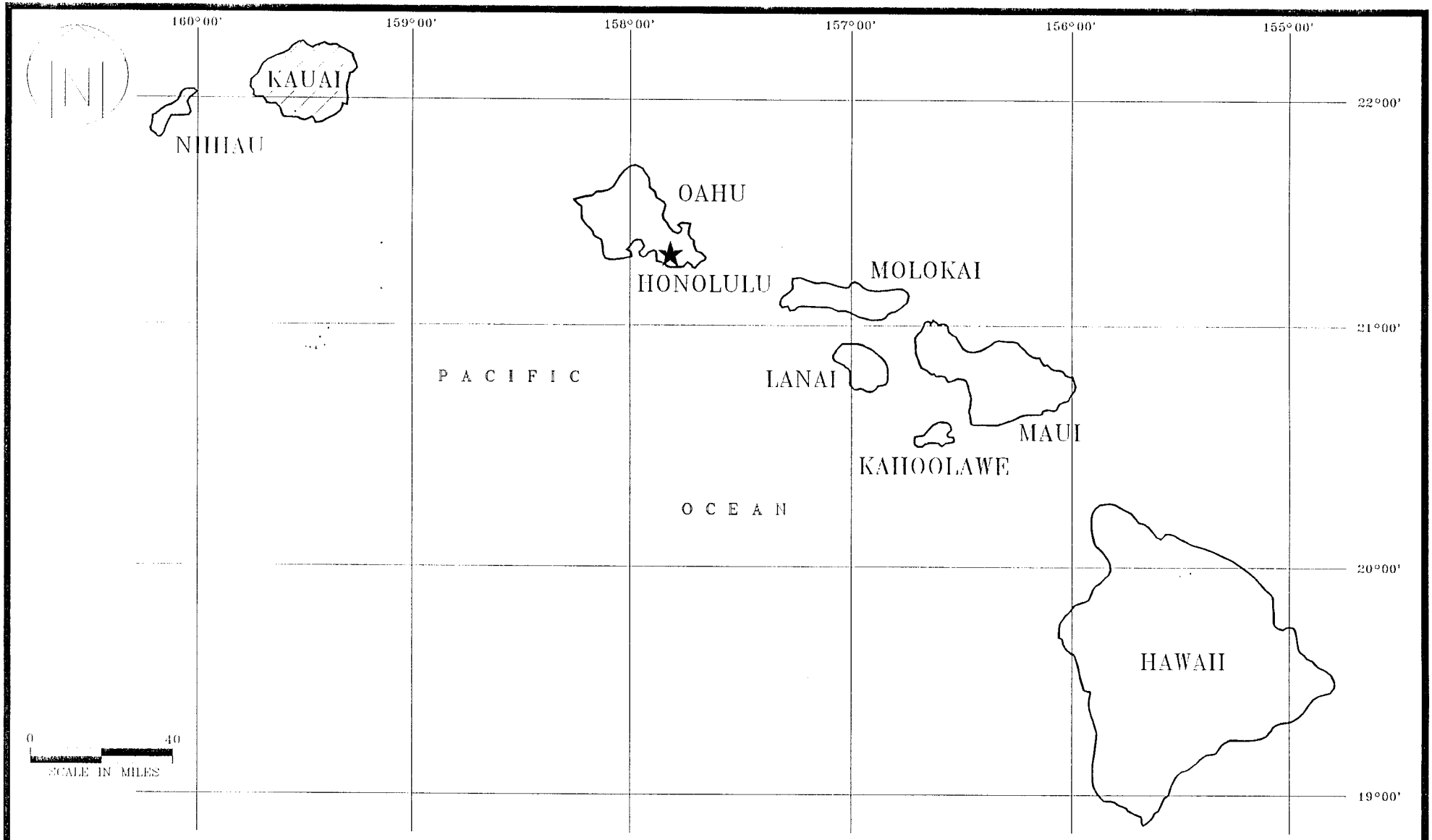
2.1 LOCATION

The Kekaha Armory (hereinafter referred to in this report as the Armory) is located in the town of Kekaha on the southwest coast of Kauai, the northernmost populated island of the State (Figure 2.1). According to the 1990 U. S. Census, the population of Kekaha is 3,506, while the population of the entire island (Kauai County) is 51,177. The installation is a 1.46-acre site containing a 10,000-square-foot wooden building with a concrete floor. The site is located on Kekaha Road, approximately 2,000 feet inland from the Pacific Ocean (see Figure 2.2). The installation is the garrison location of the 154th Air Control Squadron, which has a mission to provide radio and radar support of mission aircraft operating in the Hawaiian Islands.

2.2 ORGANIZATION AND HISTORY

The Kekaha Armory building was constructed in 1942 as a warehouse for the U.S. Army during World War II. Prior to the construction of the building in 1942, the parcel was used by the Kekaha School faculty and students as a garden plot. After the war years, the property was turned over to the County of Kauai and became part of the Kekaha School property. During the post-war years until the early 1950s, the building was used occasionally by the Kekaha Parent-Teachers Association and the Kekaha Community Association for meetings and social functions. In December 1950, and again in August 1954, the Hawaii National Guard requested that the building be turned over to the Territory of Hawaii for use by the Hawaii National Guard. The request was granted, and the property was set for use as an armory for Company M, 3rd Battalion, 298th Infantry of the Hawaii National Guard by the Territory of Hawaii in February 1955. The facility remained in use by the U.S. Army until it was transferred to the Air National Guard in 1961. The February 1955 Executive Order, which granted the property to the Hawaii National Guard, was canceled in March 1994. The cancellation agreement granted the U.S. Government a 5-year lease in order to repair the Kekaha Armory, which was damaged by Hurricane Inike. The funding is to be supplied by Federal funds through the Department of the Air Force.

The Kekaha Armory was also utilized in previous years as a support facility for the Kokee radar site. The road to the Kokee radar station was once a dirt road, and unit personnel parked their vehicles at Kekaha and were shuttled up the road to the site. During this period, the Armory served as an administration function for Kokee, as well as a main parking area.



SOURCE: SOIL SURVEY OF THE ISLAND OF HAWAII, STATE OF HAWAII, 1973.

FIGURE 2.1

KEKAHA\ISLANDS

LOCATION OF THE ISLAND OF KAUAI
IN THE STATE OF HAWAII
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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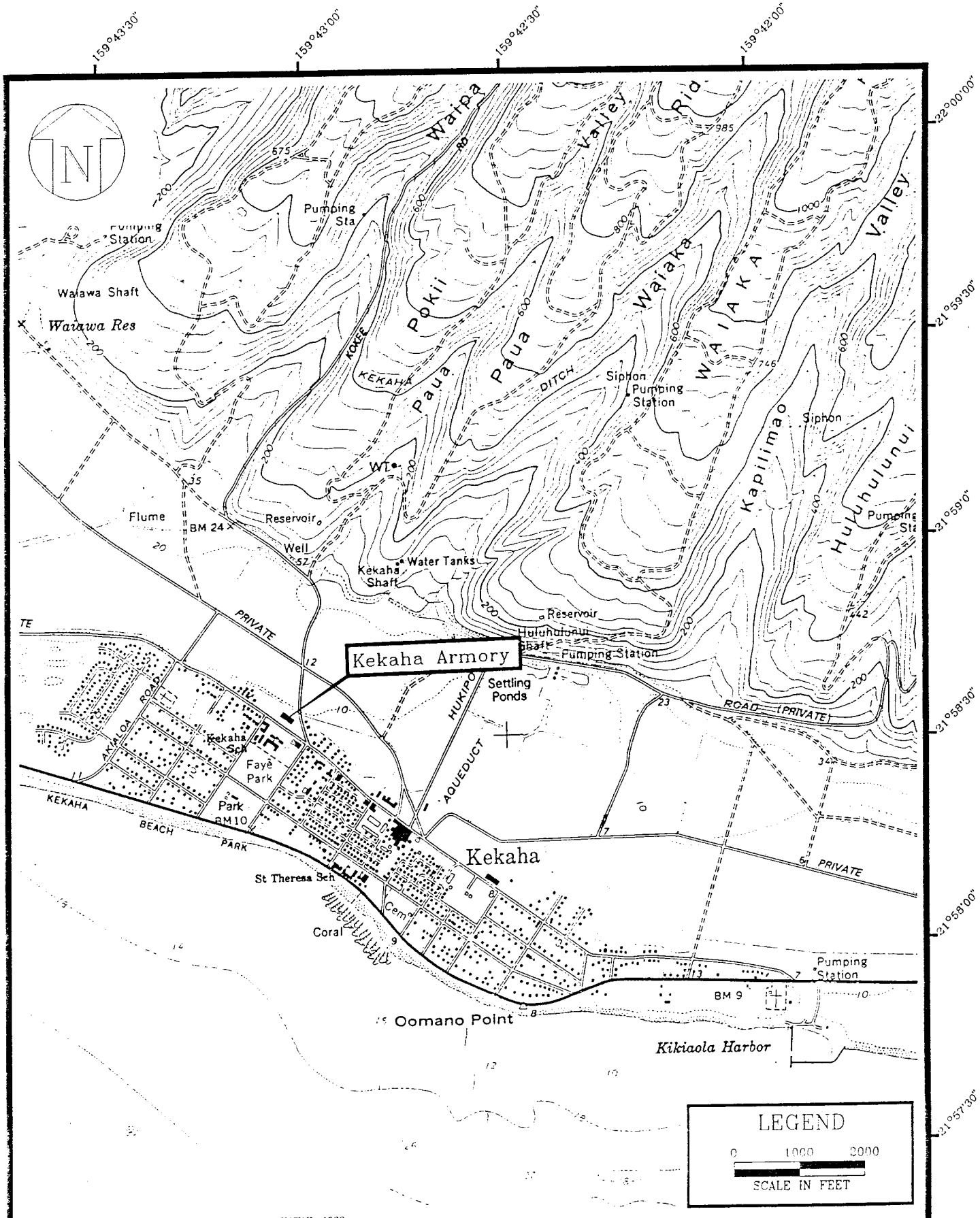

SOURCE: USGS 7.5' TOPOGRAPHIC MAP, KEKAHA, HAWAII, 1983.

FIGURE 2.2

KFIA INSTMAP

INSTALLATION LOCATION MAP

154th ACS, Kekaha Armory

Hawaii Air National Guard

Kekaha, Kauai, Hawaii

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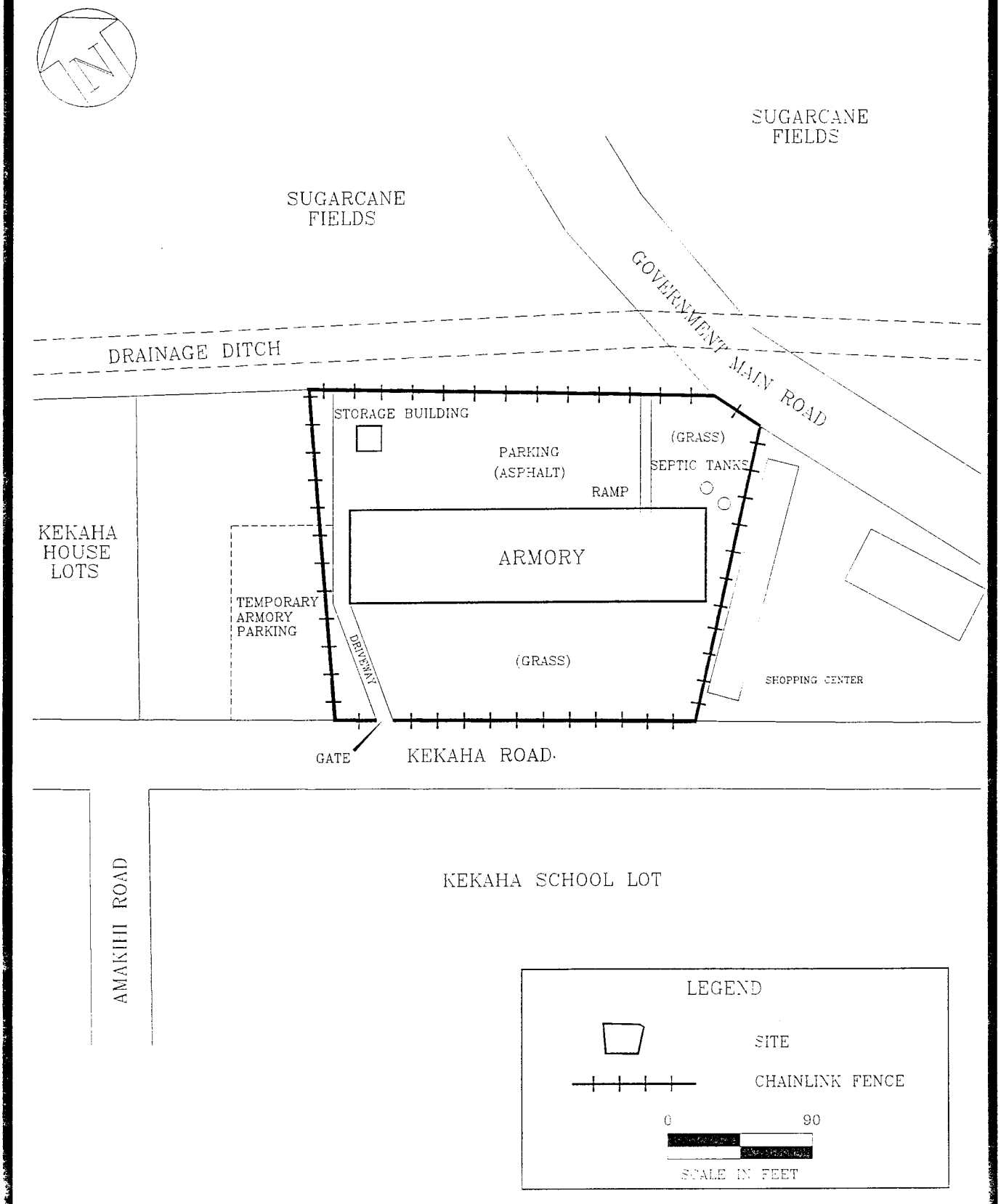
The current population of the Kekaha Armory is 25, except during Unit Training Assembly (UTA) weekends, when the population reaches 89.

2.3 SIGNIFICANT INSTALLATION FACILITIES AND INFORMATION

A new modular control equipment radar and communications package is planned for the 154th ACS, and plans are underway for the relocation of the installation to new facilities at Barking Sands Naval Station (located at the Pacific Missile Range Facility [PMRF]) within a year.

The sewage disposal system for the installation consists of two septic tanks located at the east end of the Armory building. Electrical service is supplied by County of Kauai utilities. A site plan of the property is shown in Figure 2.3.



SOURCE: MODIFIED FROM DEPT. OF ARMY AND AIR FORCE, FT. RUGER, HAWAII

FIGURE 2.3

R:\KEKAHA\SITEPLAN

KEKAHA ARMORY SITE PLAN
154th Air Control Squadron
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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SECTION 3.0 ENVIRONMENTAL SETTING

3.1 METEOROLOGY

3.1.1 Climatic Features

Among the 50 states, Hawaii is the only state surrounded by the ocean and the only one within the tropics. Both of these facts contribute significantly to its climate. The populated islands of the state are comprised of the easternmost members of the Hawaiian Island Chain. All of the islands are bordered by fringing coral reefs, and all have coasts that consist in part of sea cliffs, some of which are 300 to 3,000 feet in height.

The mountains strongly modify the marine effect and result in conditions that are semi-continental in some localities. The result is climatic conditions of great diversity. The most prominent feature of the circulation of air across the tropical Pacific is the tradewind flow in a general northeast-to-southwest direction.

In general, the Hawaiian climate is characterized by a two-season year, by mild and fairly uniform temperature conditions everywhere but at high altitudes, by strikingly marked geographic differences in rainfall, by generally humid conditions and high cloudiness except on the driest coasts and at high elevations, and by a general dominance of tradewind flow, especially at elevations below a few thousand feet. Except on high mountains, the general regime in Hawaii is one of high humidities, as compared with conditions in most other states.

3.1.1.1 Winds

The dominance of the tradewinds and the influence of terrain give special character to the climate of the islands. Tradewinds provide a system of natural ventilation much of the time throughout most of the State and bring to the land, at least in the lower lying regions, the mildly warm temperatures that are characteristic of air that has moved great distances across the tropical seas. Areas on the leeward (or "kona") coasts with reference to the tradewinds and topographically sheltered from them include the Kona Coast of Hawaii and the Barking Sands area of Kauai.

The wind conditions in Hawaii are exceedingly complex. Though the tradewinds are fairly constant in speed and though they blow a high percentage of the time across the adjacent sea and

onto the bordering lands, the relatively uniform tradewind flow is distorted and disrupted by the mountains, hills, and valleyways. In addition, there are local wind regimes along many of the coasts and on the mountain slopes.

Over the ocean around Hawaii, average windspeeds are highest during the summer tradewind period. During the summer months (May through October), the ocean winds exceed 12 miles an hour 50 percent of the time; 80 to 95 percent of the time these winds are from the northeast quadrant. During the winter (from November through April), when tradewinds are not quite as prevalent, windspeeds are in excess of 12 miles per hour about 40 percent of the time. When the tradewinds are moderate or strong--generally in excess of 14 miles per hour--they dominate the flow of air across wide reaches of the lowlands.

The prevailing winds on Kauai, as with the rest of the Hawaiian Islands, are the northeasterly trades which are present for much of the year. During tradewind weather, diurnal wind patterns occur. These patterns bring cooling breezes from the sea to replace the warmer air generated during the day over the coastal area. Major storms are chiefly events of the winter season, and they may yield very high winds from any direction. In any major, wind-producing storm, the extreme windspeeds may vary radically from one place to another, due both to the peculiarities of the storm, and to the effects of terrain. (Blumenstock and Price, 1974; Stearns, 1966)

3.1.1.2 Humidity and Cloudiness

Because of the diversity of valleys, hills, and mountains, the moisture distribution within the air that moves across Hawaii is far from uniform. Under tradewind conditions, there is very often a pronounced moisture discontinuity at heights of between 4,000 and 8,000 feet above sea level. In general, windward areas tend to be cloudier during the summer, when tradewinds clouds are more prevalent, while leeward areas, which are less affected by tradewind cloudiness, tend to be cloudier during the winter, when general storms and frontal passages are more frequent. (Blumenstock and Price, 1974)

3.1.1.3 Precipitation

Among Hawaii's outstanding climatic features are the remarkable differences in rainfall over short distances. The principal cause of this remarkable variability is the orographic, or mountain-caused, rain that forms within the moist air from trade winds as it ascends and traverses the steep and high terrain of the islands. The resulting rainfall distribution, in the

mean, closely resembles the topographic contours. The amount is great over windward slopes and crests and is least toward the leeward lowlands.

The northeastern sides of the mountains are usually wettest because of the prevailing wind. Maximum precipitation occurs between altitudes of 2,000 and 6,000 feet depending upon the form and height of each island. Above 6,000 feet the precipitation decreases, making high peaks semiarid. As the winds descend the lee slopes, they become warmer, drying winds, causing arid and semiarid climates on the leeward sides of the islands. The annual rainfall ranges from 10 inches or less on the lee coasts to about 450 inches on the wettest belts.

Hawaii is known for its disparity of rainfall in relatively short distances. Kauai is an excellent example of this phenomenon. Rainfall is greatest in the mountainous interior, and Mt. Waialwale (at Kauai's highest elevation), which receives an average annual rainfall of 486 inches per year, is known as one of the wettest spots in the world. In one year 624 inches of rain was recorded on Mt. Waialwale at an altitude of 5,170 feet. However, the town of Mana, which is only 21 miles west of Mt. Waialeale, receives an average annual rainfall of 21 inches per year. (Blumenstock and Price, 1974; Stearns, 1966)

The annual rainfall in the Kekaha area also averages 21 inches. Most rainfall occurs between November and April; there is very little rain during the summer. Of the approximately 116 million gallons per day of rainfall which falls in the drainage basin which includes the Mana Plain, approximately 43 percent is lost to evapotranspiration, 50 percent is runoff, and only 7 percent is groundwater recharge. (Takasaki, 1978)

3.1.1.4 Temperatures

There are essentially two seasons in Hawaii, summer and winter. During the summer months, temperatures range from 70°F to 88°F and the weather is warm and dry. Northeasterly tradewinds are also present most of the time. During the winter season, the weather is cooler, and temperatures range from 60°F to 83°F. Elevation also affects the temperature. An increase of every 1,000 feet realizes a decrease in temperature of 4°F. The maximum temperature rarely exceeds 90°F, and the minimum hovers around 50°F.

Temperature variations throughout the islands, except at extremely high altitudes, are very slight because of the small variation in solar energy and the virtually constant flow of fresh ocean air across the islands. The rugged configuration of the islands produces marked variations in

conditions from one locality to another. Thus, the climatic pattern reflects not only such dynamic elements as tradewind flow, the passage of storms, and the seasonal rhythms of daylight and of solar heating, but also the static element of topography.

Kauai's climate is characteristic of that of the rest of the Hawaiian Islands. It is mild and varies according to elevation and location with respect to the mountainous terrain, rather than seasonally. The average annual temperature ranges from 70°F to 78°F along the coast. The temperatures on the southwest coast of Kauai are generally mild throughout the year. The average temperature during the winter months is 70°F, while, during the summer months, the average is 78°F. (Blumenstock and Price, 1974)

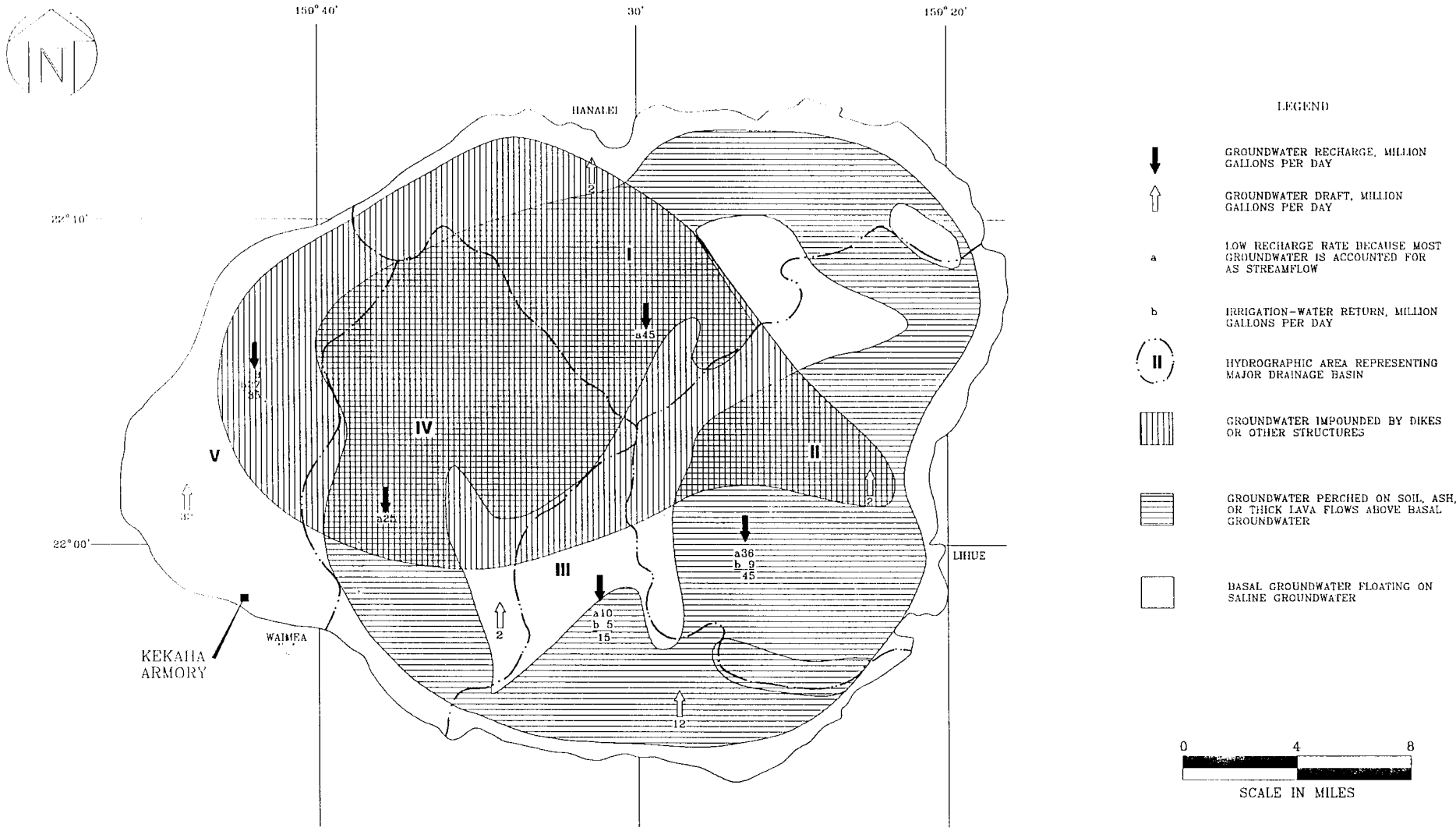
3.2 PHYSIOGRAPHIC SETTING

Kauai, 5,240 feet high and 32 miles in its longest diameter, is a dissected basaltic dome. It has an area of 555 square miles and is separated from Oahu by the Kauai Channel, about 72 miles wide and 10,000 feet deep. The island was volcanically formed, and the summit plateau is what is left of the floor of a huge caldera 13 miles across. The rim of the caldera is eroded away, and faulting and marine and stream erosion have greatly impacted the original nearly circular dome.

3.2.1 Topography and Drainage

The major Hawaiian islands are basaltic volcanic domes in various stages of dissection. The great permeability of the basalt and coral rock has an important bearing on the geomorphology of the islands. Because temperatures are uniformly high and, except on high peaks, not below freezing, chemical weathering dominates over mechanical disintegration. Gradually, thick soils form and reduce the porosity of the slopes, and stream courses develop. Marine erosion is more effective on the northeast or tradewind coasts where sea cliffs of nearly 3,000 feet have been cut.

The larger islands were subdivided into hydrographic areas by the Hawaii Water Authority in 1959. The boundaries of the areas are based on topography and generally outline the major surface drainage basins. The major drainage basins and groundwater reservoirs of Kauai are shown in Figure 3.1.



SOURCE: MODIFIED FROM TAKASAKI, 1978.

FIGURE 3.1

R\KEKAHA\REGION

MAJOR DRAINAGE BASINS AND GROUNDWATER RESERVOIRS, ISLAND OF KAUAI

154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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The Kekaha Armory is located on the Mana Plain of Kauai at 22°00' North latitude and 159°42' West longitude. The Mana Plain is a narrow strip of low-lying beach, underlain by coral reefs, at the foot of steep volcanic ridges and canyons.

Although the area topography slopes gently toward the ocean, the area surrounding the installation is relatively level, with the elevation of Kekaha Armory at approximately 10 feet above mean sea level (MSL). The Armory building itself lies at a lower elevation than Kekaha Road and the north and south portions of the installation property. Therefore, drainage moves toward the interior of the parcel from the north and south portions of the property (see Figure 3.2). According to unit personnel, drainage around the Armory is poor. Large ponds are formed adjacent to the building after rain events, and standing water was observed in the grass on the northeast side of the building during the site visit.

3.2.2 Floods

The Flood Boundary and Floodway Map of the County of Kauai, published by the Federal Emergency Management Agency of the Federal Insurance Administration, shows the relationship of the installation to the 100-year Flood Boundary and the Coastal High Hazard Area (tsunami hazard). The coastline is considered a "Coastal High Hazard Area" for approximately 200 feet inland. Although the installation is not located in the Coastal High Hazard area, it is located within the 100-year Flood Boundary.

3.3 GEOLOGY

3.3.1 Regional Geology

The Earth's solid surface is divided into a dozen or so more or less rigid plates, 35 to 70 miles thick, which move laterally relative to each other over a zone of low rigidity in the upper part of the Earth's mantle. These plates have several types of boundaries, one being spreading boundaries in which adjacent plates are moving away from each other. These spreading boundaries lie mostly along the great series of ridges which girdle the Earth, largely on the ocean floors, and seismic activity along such ridges contributes to the source of new crustal material.

Hawaii is located within the Pacific Plate, and researchers agree that Hawaii is underlain by what is called a mantle plume. Mantle plumes are relatively narrow columns of hot mantle that

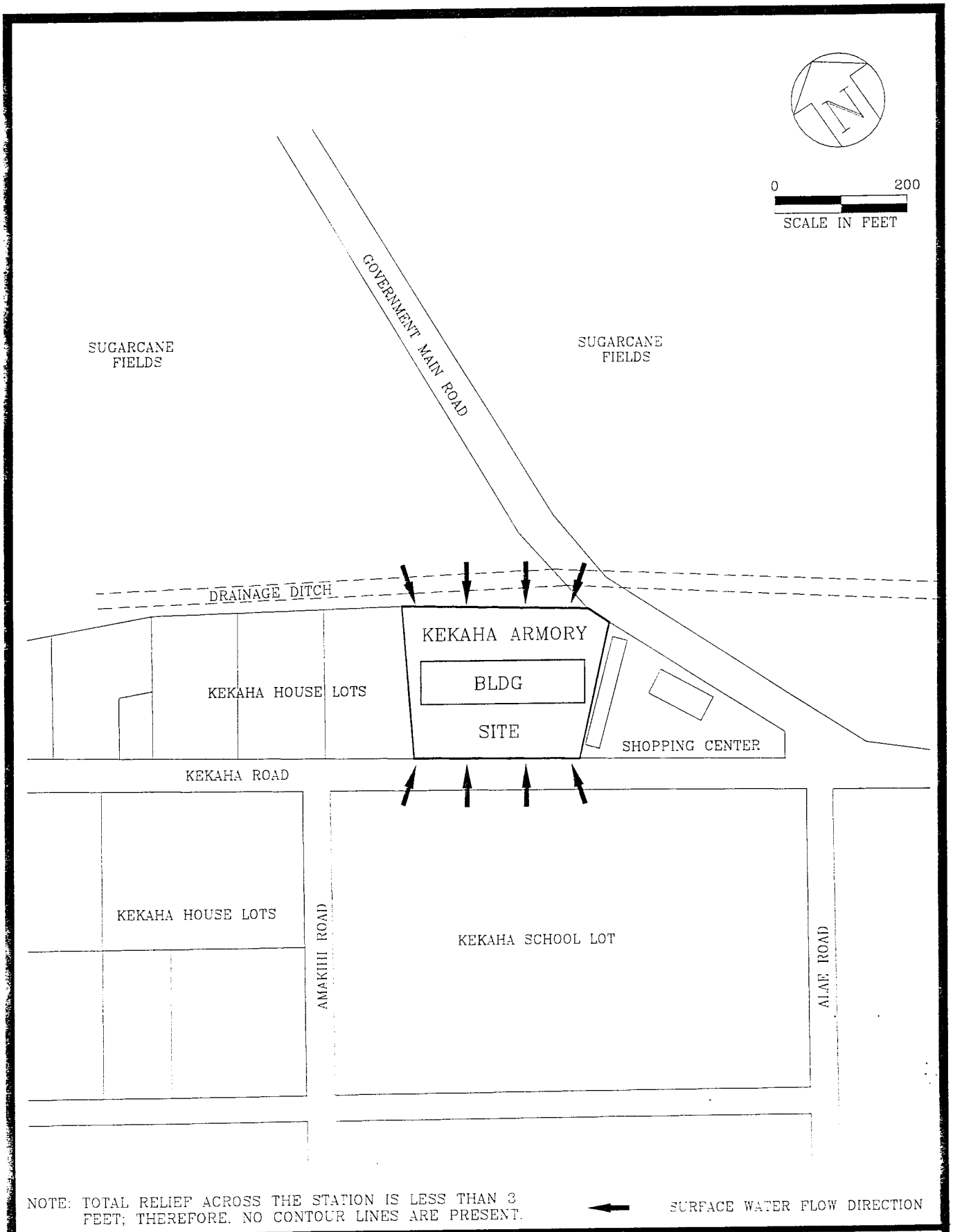

FIGURE 3.2

R:\KEKAHA\KEKAHA

SURFACE WATER DRAINAGE
154th Air Control Squadron
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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rise from deep within the mantle. These plumes are found within plates and at divergent boundaries between plates. It has been recognized, on the basis of the degree of weathering and erosion, that the Hawaiian volcanoes decrease progressively in age from the northwest to the southeast, and it is believed that this is the result of the northwestward movement of the Pacific plate across a hot, magma-generating spot in the mantle, magma rising through the plate to form a volcano. The center of the plume underlying Hawaii is located close to Mauna Loa and Kilauea on the island of Hawaii. Radioactive dating of the lavas of Hawaiian volcanoes has confirmed the general southeastward decrease in age.

The Hawaiian Islands are a chain of shield-shaped basaltic domes built over a fissure 1,600 miles long in the ocean floor. The feature has existed since at least early Tertiary and probably longer. The lava now rises along tension cracks bounding blocks strung out linearly from southeast to northwest.

The larger, high volcanic islands probably were built above sea level in Pliocene time. Periods of eruptions resulted in island building, and the following periods of volcano dormancy and erosion resulted in the formation of deep canyons and high cliffs, with soils 5 to 100 feet thick forming in some areas. A period of great submergence followed the long erosion period, and then a new epoch of volcanism began, with secondary outbreaks continuing into the Holocene (or Recent) Epoch.

Each of the islands consists of one to five volcanic domes, the bulk of which is composed of thousands of basaltic lava flows. The lavas issued in repeated outpourings from narrow zones of fissures associated with each volcano, first below sea level, then above it, to form huge mountain masses. The basaltic lavas that were extruded above sea level are generally thin-bedded, highly clinkery, and highly permeable. All of the islands have sunk, to some extent, to adjust isostatically for their great weight on the earth's crust. Consequently, the highly permeable lava flows, which were originally extruded above sea level, now extend some distance below it. This rock assemblage of highly permeable basaltic lava flows makes up the principal reservoirs for groundwater in the Hawaiian islands.

Fissure eruptions characterize Hawaiian volcanoes. Seismic records indicate that the magma starts rising from the mantle about 35 miles below the surface and forms a reservoir within the crust at a depth of several miles. From there it finds its way to the surface through narrow dikes (areas of igneous intrusion). The usual eruption is preceded by a local earthquake as the ground opens to allow the exit of the magma. The fissures are a few inches to a few feet wide,

and, during the rapid dome-building epoch, are limited to definite rift zones. The widest single dike known in Hawaii is 40 feet across; the average width is about 2 feet. Eruptions often begin with a lava fountain which is caused by frothing at the top of the lava column when pressure on the enclosed gases is released. Rivers of pahoehoe pour from the fissure, but as it flows down the mountainside, the lava usually changes to Aa. Recorded eruptions have lasted from a few hours to 18 months, and the flows have ranged in length from a few feet to 35 miles.

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Hawaiian eruptions are self-extinguishing because eruption of lava to the surface is far more rapid than its replenishment from the source far below. Exposed parts of the Hawaiian volcanoes contain by volume less than one-half of 1 percent of explosive debris, thus indicating the dominance of lava outpourings. The flows range from a few inches to 900 feet in thickness, but most are from 10 to 30 feet. The main bulk of the domes consists of lava beds dipping 3° to 10° away from their source and rarely separated even by thin soil beds. Thin soils between flows in some volcanoes show that the time interval between eruptions lengthened toward the close of the dome-building epoch. Many of the soil beds are decomposed vitric tuff which, during the early phase of eruption, generally is deposited in small quantities by lava fountains near the vents.

Landscape features of volcanic origin may be either positive forms, the result of accumulation of volcanic materials, or negative forms, the result of lack of accumulation or of collapse. Both features are found in the State of Hawaii. Fissure eruptions which occur repeatedly along the same zone of fissures result in a broadly rounded dome-shaped hill or mountain known as a shield volcano. Shield volcanoes consist almost wholly of innumerable superimposed thin lava flows. Small bowl-shaped depressions formed by explosion are known as craters, and most of

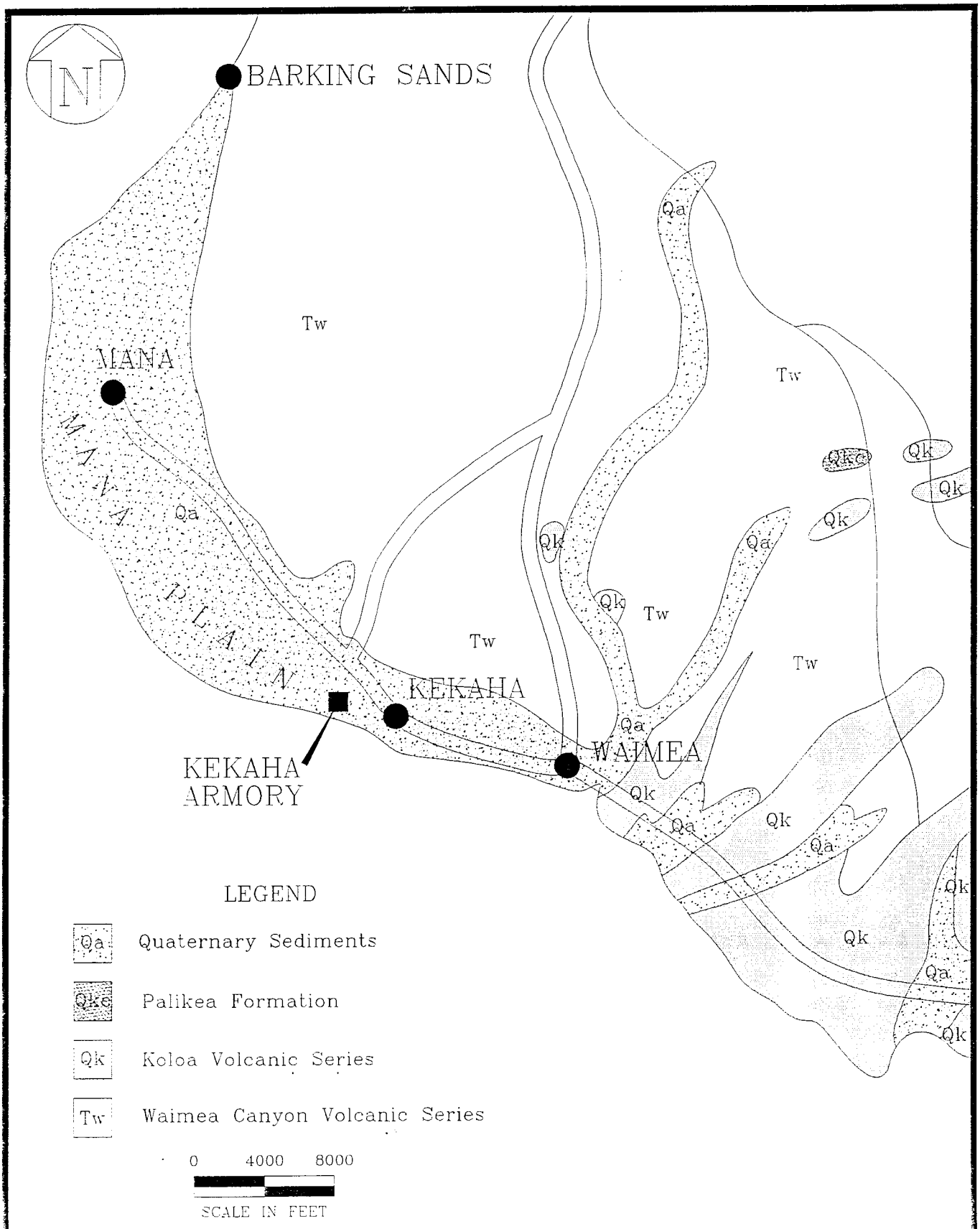
them are found on the flanks of volcanic cones. A larger depression at the summit of volcanic cones is formed by collapse of the summit as the support beneath it is removed by the rapid withdrawal of magma. A depression of this sort is called a caldera.

Phreatic and phreatomagmatic explosions have occurred sparingly. Such violent explosions may throw dust and ash high into the stratosphere, where it may drift for thousands of miles (ash from eruptions of Iceland has fallen in the streets of Moscow). Most of the solid fragments in the cloud settle out within a few days, and nearly all within a few weeks, but some finely divided material may remain suspended in the stratosphere for more than a year. (McGraw-Hill Encyclopedia of the Geological Sciences, 1978; and The Encyclopedia of Structural Geology and Plate Tectonics, 1987)

3.3.2 Local Geology

Kekaha is located on the southwest coast of Kauai on the Mana Plain, a coastal plain with an ancient sea cliff at its inner edge, which extends from Waimea in the south to Barking Sands in the north (see Figure 3.3). The Mana Plain strata is composed of sedimentary rocks of alluvium, beach and dune sand and lagoonal clays and marls laid down during the Holocene (Recent) and late Pleistocene epochs (see Geologic Time Scale in the Glossary) on the remnants of early Napali lava flows. During periods of low sea level, these lagoonal sediments formed broad flats, and former sea cliffs were abandoned inland. These ancient sea cliffs were cut by marine erosion when the sea level was at a higher stand than it is now. After the sea level dropped, the plain gradually grew as alluvium washed down from the uplands and combined with calcareous and earthy lagoon deposits and calcareous beach and dune sand. This has resulted in a relatively thick sedimentary layer. The sediments have been found to consist of clays, sand, gravel, boulders and corals. The Mana Plain is underlain by coral reefs at minus 60 feet and minus 120 feet, and the sediments bottom at minus 390 feet. The minus 60-foot reef may have been formed during the Waipio low, a period of extensive dune formation, and the minus 390-foot bench was probably cut during one or more of the low stands of the sea during the Pleistocene Epoch. (Stearns, 1966)

A lithologic description of the geologic units underlying Kauai is presented in Table 3.1.



SOURCE: GEOLOGICAL HIGHWAY MAP OF THE STATE OF ALASKA AND THE STATE OF HAWAII, MAP NO.8, 1974.

FIGURE 3.3

R:\KEKAHA\SOILMAP

GEOLOGIC MAP
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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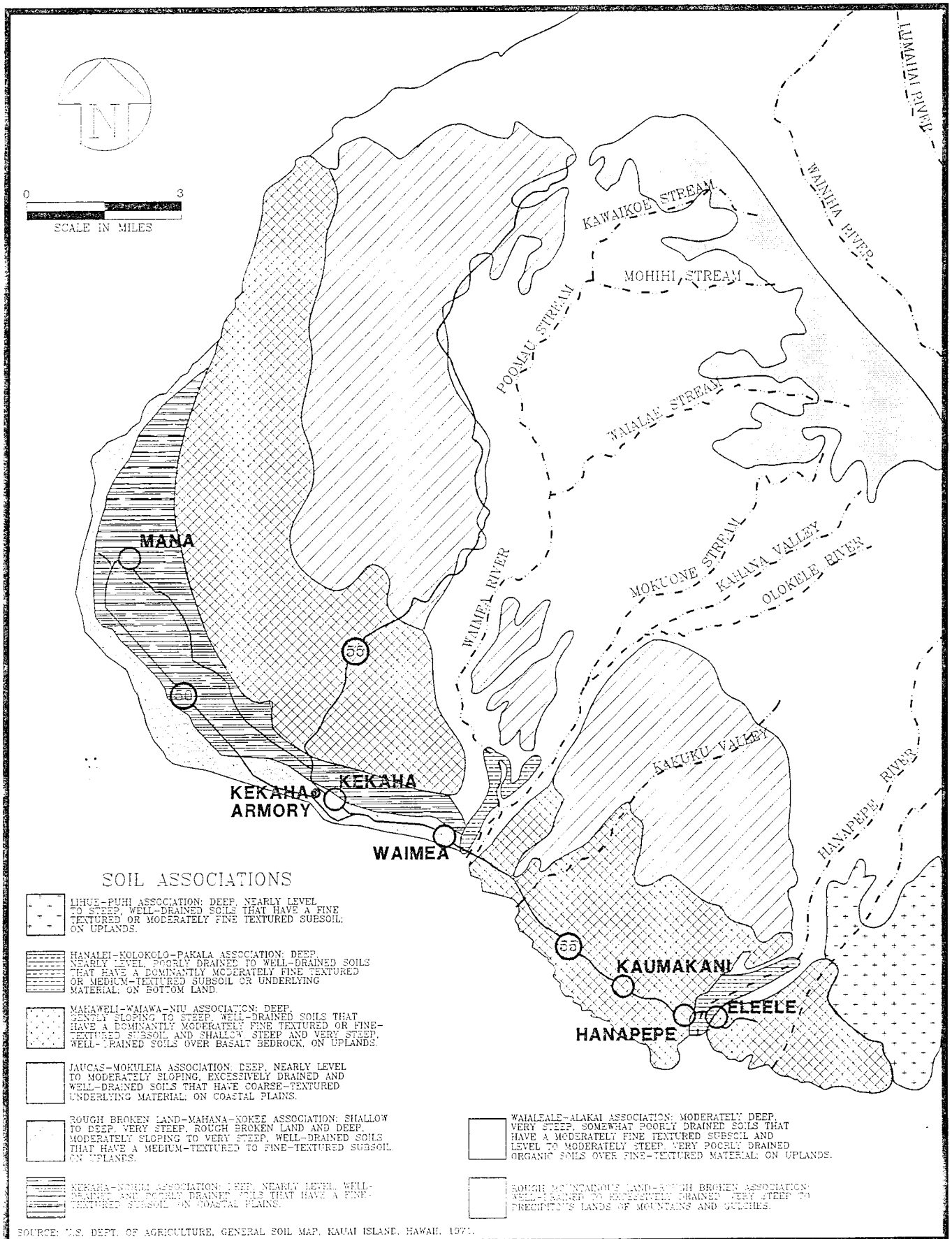
Table 3.1
Stratigraphic Rock Units on the Island of Kauai

Age	Rock Assemblage	
	Sedimentary Rocks	**Volcanic Rocks**
Recent	Beach and dune sand and alluvium	
Local Erosional Unconformity		
Pleistocene	Lagoonal deposits of Mana Plain, older alluvium, lithified dunes and the Palikea formation comprising mud-flow breccias, and conglomerates interstratified with and at the base of the Koloa volcanic series.	Koloa volcanic series, comprising a tuff cone at Kilauea Bay, ash and tuffaceous soil beds, cinder cones and lava flows, many of them filling valleys.
MAJOR EROSIONAL UNCONFORMITY		
Pliocene	Makuone member of the Makaweli formation, comprising masses of breccia along the contacts of the Makaweli formation with older rocks and beds of well sorted conglomerates interbedded with the Makaweli formation.	Waimea Canyon volcanic series comprising the Napali formation of cones, flows, and intrusives forming the major shield-shaped dome outside the caldera; the Olokele formation, thick flows which accumulated in the broad caldera on the summit; the Makaweli formation, flows which accumulated in a graben on the southwest slope; the Haupu formation; massive flows which accumulated in a small caldera on the southeast slope.

Source: Stearns, H. T., Geology of the State of Hawaii, 1966

3.3.3 Soils

The soil found at the Kekaha Armory belongs to the Jaucas series of the Jaucas-Mokuleia soil association and is known as Jaucas loamy fine sand, 0 to 8 percent slopes (Figure 3.4). It is characteristically found on old beaches and on windblown sand deposits. Permeability is rapid, and runoff is very slow to slow. The hazard of water erosion is slight, but wind erosion is a severe hazard where vegetation has been removed. The soil is neutral to moderately alkaline throughout the profile. Uses that are associated with this soil type are pasture, recreational areas, wildlife habitat, sugarcane and alfalfa. Because of its low capacity to hold water, it is not suitable for crop farming unless it is well irrigated. (U.S. Department of Agriculture, Soil Conservation Service, 1972)



SOURCE: U.S. DEPT. OF AGRICULTURE, GENERAL SOIL MAP, KAUAI ISLAND, HAWAII, 1972.

FIGURE 3.4

HAHULUI SOILS

SOILS MAP

154th ACS, Kekaha Armory

Hawaii Air National Guard

Kekaha, Kauai, Hawaii

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3.4 HYDROLOGY

3.4.1 Groundwater

Groundwater is Hawaii's most valuable mineral resource. Without it there would be no cities, no tourist business, and no sugar industry. Rainfall is the principal source of recharge, and its quantity and variability are significant in determining the extent and quality of groundwater. Groundwater development is generally most favorable in areas directly downslope from mountain areas of high rainfall and becomes less favorable with increasing distance away from these downslope areas. Seawater is the biggest pollutant of freshwater, and many of the islands' problems are associated with the encroachment of saline water induced by development. As a result of development, the quality of the groundwater has deteriorated at some places, but water of less than potable quality can be tolerated in uses such as cooling and irrigation of sugarcane. (Takasaki, 1978)

The principal fresh groundwater reservoirs consist of thin-bedded basaltic lava flows; the permeability of basalts exceeds that of most other rocks on earth. The potential yield from basaltic lava flows is due to interstitial spaces in the basalt, cavities between beds, shrinkage cracks, lava tubes, and gas vesicles. Some lava tubes are 30 feet in diameter and, where they occur in the zone of saturation, are capable of transmitting vast quantities of water. Most fresh groundwater is stored near and below sea level to depths ranging to 1,000 feet or more below sea level. The groundwater reservoirs contain interconnected water bodies that are impounded by dikes in the interior of the islands or are in dynamic equilibrium with the underlying saline groundwater in the outer rim of the islands. (Stearns, 1966)

The larger islands were subdivided into hydrographic areas by the Hawaii Water Authority in 1959. The boundaries of the areas are based on topography and generally outline the major surface drainage basins (see Figure 3.1). Also included in Figure 3.1 are estimates of groundwater recharge and withdrawals, or draft, from these hydrographic areas. (Takasaki, 1978)

Underlying the Mana Plain are two aquifers having distinctly different hydrologic properties. They are the coastal plain sedimentary aquifer and the basaltic aquifer. The coastal plain aquifer, with a thickness of over 400 feet, retards the seaward and upward discharge of groundwater from the basaltic aquifer. The coastal plain aquifer is used for agricultural purposes (irrigation) but is not used as a source of drinking water. The basaltic aquifer

underlying the coastal plain aquifer is composed of the lava flows constituting the Napali Formation. The basaltic aquifer of the Napali Formation yields large quantities of water to wells and shafts with relatively little drawdown, reflecting a high hydraulic conductivity.

There are a number of wells and shafts that have been sunk to utilize the basal groundwater of the Mana Plain. Wells were probably first drilled in the early 1880s. and the first shaft and basal tunnel was constructed in 1931 at the base of the ancient sea cliff near Kekaha. After 1931, six more shafts were installed along the inland edge of the plain until 1957. Water from these shafts is used for domestic and agricultural purposes. Shaft type wells are advantageous in that they can tap basal water as high as possible above the transition zone. These wells normally produce water of a better and more uniform quality than deep drilled wells. (Stearns, 1966)

The potable water supply for the installation is obtained from groundwater sources and is supplied by a pipeline from the town of Kekaha. According to the State of Hawaii Department of Health, Safe Drinking Water Branch, there are four drinking water supply sources within a one-mile radius of the Kekaha Armory. These wells and shafts are located in the mountains north and upgradient of the installation (see Figure 3.5). Three of the water sources are owned by the Kauai Department of Water Supply, and the fourth is owned by the Kekaha Sugar Company. Information on these water sources is provided in Table 3.2.

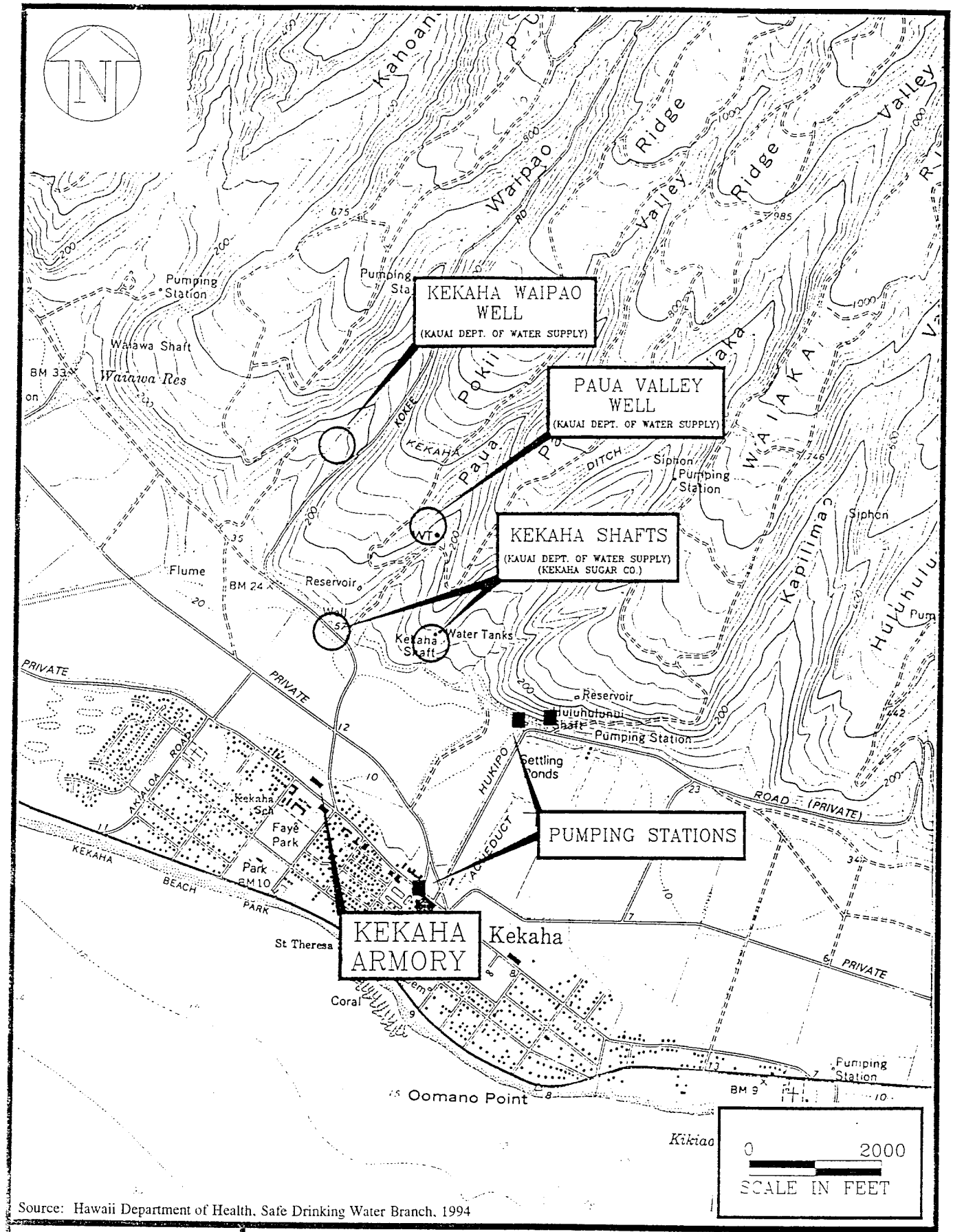
Table 3.2
Water Sources Within One-Mile Radius of Kekaha Armory
Kekaha, Kauai

Name	Year Constructed	Depth (feet)	Water Table Depth (ft AMSL)	Specific Capacity[1] (gpm/ft)	Water Quality[1]
Kekaha Waipao (DWS)	1978	220	7.5	60	Good
Paua Valley (DWS)	1970	210	9.4	78	Good
Kekaha Shaft (DWS)	1948	53	11.0	5,000	Fair
Kekaha Shaft (Kekaha Sugar)	1932	57	N/A	N/A	Fair

Source: State of Hawaii, Department of Health, Safe Drinking Water Branch and Department of Land and Natural Resources, Commission on Water Resource Management

[1] Specific capacity of discharge (gallons per minute) divided by the drawdown (feet) in a pumping well. Measurements of specific capacity and water quality were obtained during pump tests.

DWS – Department of Water Supply
ft AMSL – Feet above mean sea level.
gpm/ft – Gallons per minute per foot.
N/A – No information available.



Source: Hawaii Department of Health, Safe Drinking Water Branch, 1994

FIGURE 3.5

F:\ACAD\FORMS\KEKAHA

DRINKING WATER SOURCE LOCATIONS
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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Additionally, three pumping stations are located within a one-mile radius of the Kekaha Armory; two are on Hukipo Road, northeast of the installation, and a third is southeast of the installation within the town of Kekaha. The locations of the pumping stations are also shown on Figure 3.5. No contamination has been found in any of these drinking water supply sources. (Department of Health, Safe Drinking Water Branch)

3.4.2 Surface Water

Perennial streams flow to the sea along most of the coast of Kauai. There, the low flow of the streams is maintained by persistent rainfall in the mountains and by perched springs. Due to the highly permeable soils in the area, no deep, well-defined streams are found on the Mana Plain. However, discharges from streams of the numerous valleys on the inland edge of the plain feed into the irrigation systems for sugarcane plantations in nearby and adjacent areas (these irrigation systems are not considered state waters of the United States under the Clean Water Act). Surface water is carefully conserved for irrigation and is stored in a number of small reservoirs on the Plain. Great complexes of tunnel and ditch systems carry the surface water to the cane fields.

The Waimea River, which flows through the extremely steep Waimea Canyon, lies approximately 3.5 miles northeast of the Armory. Aside from this waterway, most of the area's surface water sources consist of small impoundments located in the mountains north of the Armory, larger impoundments and reservoirs located along the Mana Plain, and an extensive system of aqueducts and ditches which carry water to the sugarcane fields located along the Plain (Figure 3.6).

3.5 CRITICAL HABITATS/ENDANGERED OR THREATENED SPECIES

Prior to its present use as sugarcane fields, the Pacific Missile Range Facility, etc., the Mana Plain was once a swamp. Subsequent to its conversion to sugarcane fields, much of it has been altered beyond the original landscape. The result has been the elimination of many native species on the Plain.

According to the U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, several species of endangered birds and plants may be found within a 5-mile radius of the Armory, in addition to one mammal, the Hawaiian hoary bat, which was last sighted in the area in 1991. The endangered birds include the Hawaiian coot, Hawaiian moorhen, and Hawaiian stilt (all last

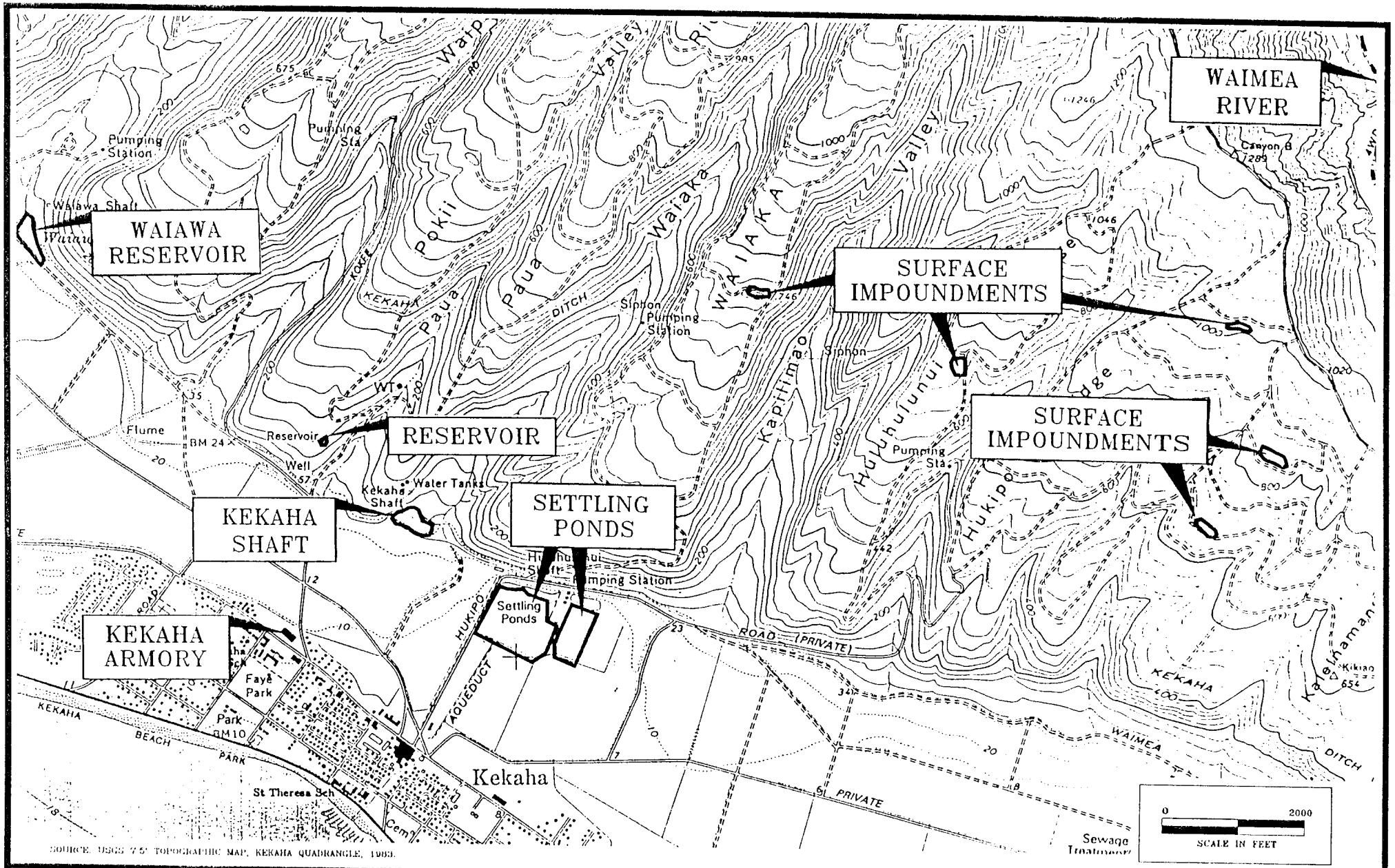

FIGURE 3.6

KEKAHA\IMPOUND

AREA SURFACE WATER LOCATIONS
154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

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JANUARY 1995

sighted in 1990), and the Hawaiian duck, last sighted in 1989. An endangered plant, Nehe, is extremely rare and was last sighted in the area in 1991; *Schiedea spergulina*, a threatened plant species, was last sighted in the area in 1985.

As previously mentioned, the Waimea River, located less than 5 miles from the Armory, is a perennial waterway that empties into Waimea Bay. Based on surveys conducted in 1990 by the State of Hawaii, two species of native freshwater gobies, *Awaous stamineus* and *Sicyopterus stimpsoni*, occur in the Waimea River.

The Pacific Ocean lies approximately 2,000 feet from the Kekaha Armory, and species which may be found in the marine environment near the area include the threatened green turtle *Chelonia mydas*, and endangered hawksbill turtles (*Eretmochelys imbricata*), Hawaiian monk seals (*Monachus schauinslandi*), and humpback whales (*Megaptera novaeangliae*). Because the Armory is relatively far removed from the marine environment, no effect to any listed species as a result of activities at the Armory is anticipated. (National Marine Fisheries Service)

A survey of the flora and fauna of the proposed Kekaha Landfill site, approximately 1.3 miles northwest of the Kekaha Armory, was performed on August 6, 1982 by the Kauai Office of the Division of Forestry and Wildlife, Department of Land and Natural Resources, State of Hawaii. The survey results stated "It is highly unlikely that any uncommon or rare natural plants exist within the landfill sites. Fauna likely to exist at the landfill site are the common species of dogs, mice, rats, and chickens." (Towill, 1983)

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SECTION 4.0 AOC EVALUATION

4.1 BACKGROUND WASTE GENERATION

A review of installation records and interviews with installation personnel resulted in the identification of specific operations at Kekaha Armory in which industrial chemicals are handled and hazardous wastes are generated. Operations at the installation which generate hazardous waste consist of minor vehicle maintenance and power generation equipment maintenance. Only very small quantities of waste solvents, motor oil, paint, paint thinner, and used batteries are generated. Historical methods of disposal are shown in Table 4.1. Any operation that is not listed on Table 4.1 has been determined to produce negligible quantities of wastes requiring disposal.

Waste oils and solvents are temporarily stored in 55-gallon drums, and spent lead acid batteries are temporarily stored on pallets, prior to transport to PMRF for recycling or disposal. The 55-gallon drums are stored on pallets against the back (north) fence line. Unused paints are stored in a small metal shed at the rear of the Armory building.

Interviewees reported that no liquid wastes from shops have been in the past or are currently disposed in the drains which empty into the septic tanks. Several interviewees reported a former practice of giving waste oil to the adjacent sugarcane plantation to burn for fuel and to use for dust control on plantation roads; however, this practice has been discontinued.

Only minor vehicle maintenance is conducted at the installation; all major vehicle repair and maintenance is conducted offsite. Vehicle washing is conducted onsite, however, at the northeast corner of the installation at the furthest edge of the asphalt. During the site visit, no soil staining or distressed vegetation was noted in this area.

There are no underground storage tanks (USTs) located on the installation. However, in May 1993 during an attempted theft of gasoline at the installation, approximately 145 gallons of unleaded fuel were released from a fuel trailer in the northwest corner of the installation. Fuel ran approximately 20 to 30 feet east on the asphalt surface in an area approximately 5 to 10 feet wide and evaporated or soaked in. No residual fuel was left on the asphalt surface. Contaminated asphalt and soil were removed by a contractor and moved to a concrete pad at Barking Sands Naval Station. Four soil samples were taken for initial laboratory analysis, and the soils were subsequently remediated using a bioremediation product called "Bio-Solve;" the

Table 4.1
Inventory of Hazardous Materials Used at 154th ACS
Kekaha Armory, Kekaha, Kauai

Shop	Possible Waste Materials	Approx. Quantities on Inventory (Gallons)	Approx. Quantities Disposed per year (Gallons)	Methods of Disposal		
				1970s	1980s	Present
Vehicle Maintenance	Solvents	225	28	PMRF	PMRF	PMRF
	Hydraulic Oil	10.5	4	PMRF	PMRF	PMRF
	Motor Oil	260	53	PMRF	PMRF	PMRF
	Brake Fluid	31	3	County	County	PMRF
	Diesel Fuel	300	50.5	PMRF	PMRF	PMRF
Paint Shop	Paints	36	2	County	County	-- [3]
	Paint Spray Cans	335 ea.	216 ea.[1]	County	County	County
Battery Shop	Used Batteries (Wet Cell)	--	16	County/ Civ	County/ Civ	PMRF
	Sulfuric Acid	20	-- [2]	County/ Civ	County/ Civ	PMRF

ea. – each.
Civ - Disposed of through Civilian Contractor.
County - Disposed of at dumpster.
PMRF - Disposed of through the U. S. Navy at Pacific Missile Range Facility.

Notes:
1. Aerosol spray cans are used to the full extent. All propellent is sprayed out; if can is empty, it is then disposed in dumpster.
2. Sulfuric acid is used to charge batteries, and all used batteries are turned in wet.
3. Paints are used to the full extent, and only the cans are disposed in dumpster.

excavation was then filled with clean fill, graded, and covered with a cold-mix asphalt by the U.S. Navy. Four additional soil samples of the remediated soil at Barking Sands were taken at the ends of the concrete pad and at 20-foot intervals between the ends. Concurrence of remediation results by the State of Hawaii Department of Health was granted, and the fuel spill event was closed out in January 1994.

4.2 AOC DESCRIPTION, EVALUATION AND HAZARD ASSESSMENT

No formal areas of concern at Kekaha Armory have been identified for further investigation.

4.3 OTHER PERTINENT INFORMATION

4.3.1 Offsite Areas

4.3.1.1 Adjacent Lot

An adjacent undeveloped 80-foot by 230-foot lot west of the Armory is occasionally used as a vehicle parking area by installation personnel. The lot is bounded on the east side by the Armory, on the north side by the Kekaha Sugar Company sugarcane field, on the west by a residential lot, and on the south side by Kekaha Road. The lot is under consideration for lease by the Hawaii Air National Guard as additional parking space for military and private vehicles. With the exception of fencing the parking area, no other improvements are planned by the ANG.

The lot is currently used by the owner to park private vehicles and two commercial fishing boats. There are also two wrecked cars, a wrecked van and some old construction materials on the rear (north) portion of the lot. Occasionally two small fuel trailers are stored there to service the boats. In May 1993, diesel fuel from one fuel trailer spilled onto the ground and contaminated the soil. The soil was tested by Hickam AFB personnel and found to contain high levels of hydrocarbons (one sample contained 68,600 parts per million [ppm] hydrocarbons). The owner has agreed to excavate and remove the soil prior to lease by the ANG. After lease negotiations and prior to signing the lease, the area will be resampled to ensure the spill has been cleaned up, and the hole will be filled with clean soil.

4.3.1.2 Kekaha Landfill

The Kekaha Landfill is located on the Mana Plain, approximately 1.3 miles northwest of the Kekaha Armory. The landfill, bounded on the east by Kaumaulii Highway and on the west by Kokele Lighthouse Road, is 1,800 feet from the coastline. The landfill site is on property owned by the State of Hawaii. The original phase (Phase I) of the landfill has reached its permitted capacity and is currently accepting no further wastes. Phase I of the landfill has undergone closure, and Phase II is now in operation. As part of the island's solid waste management plan, a recycling facility is also proposed at the area. According to environmental studies conducted for the Phase I closure and the proposed recycling facility, no significant adverse effects on the environment are anticipated.

The Kekaha Landfill site does appear on the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) listing. However, after a Preliminary Assessment conducted in November 1988, the USEPA recommended no further action at the site.

SECTION 5.0 CONCLUSIONS

No AOCs will be further investigated.

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SECTION 6.0 RECOMMENDATIONS

No further IRP investigation is warranted since no formal AOCs have been identified.

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GLOSSARY OF TERMS

AA - A Hawaiian term for lava flows typified by a rough, jagged, clinkery surface.

ALLUVIAL - Pertaining to or composed of alluvium or deposited by a stream or running water.

ALLUVIUM - A general term for detrital deposits made by streams on river beds, flood plains, and alluvial fans. The term applies to stream deposits of recent time.

ANDESITE - A dark-colored, fine-grained extrusive rock.

ANNUAL PRECIPITATION - The total amount of rainfall and snowfall for the year.

AQUIFER - A body of rock that is sufficiently permeable to conduct groundwater and yield economically significant quantities of water to wells and springs.

ARTESIAN - A hydrologic condition whereby groundwater is confined, under pressure greater than atmospheric, by overlying, relatively impermeable strata.

ASH – Fine pyroclastic material (under 2.0-millimeter diameter).

BASALT - A dark-colored igneous rock, commonly extrusive, composed primarily of calcic plagioclase and pyroxene; the fine-grained equivalent of gabbro.

BASIN - (a) A depressed area with no surface outlet; (b) A drainage basin or river basin; (c) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated.

BAY - A wide, curving open indentation, recess, or inlet of a sea or lake into the land or between two capes or headlands, larger than a cove, and usually smaller than, but of the same general character as a gulf.

BED (stratigraphy) - The smallest form of a unit in the hierarchy of lithostratigraphic units. In a stratified sequence of rocks, it is distinguishable from layers above and below. A bed commonly ranges from a centimeter to a few meters.

BEDDING (stratigraphy) - The arrangement of sedimentary rock in beds or layers of varying thickness and character.

BEDROCK - A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

BRECCIA – A coarse-grained clastic rock composed of angular broken rock fragments held together by a mineral cement or in a fine-grained matrix.

CALCAREOUS - Containing calcium carbonate. When applied to a rock name, it implies that as much as 50% of the rock is calcium carbonate.

CALDERA - A large basin-shaped volcanic depression.

CINDER CONE – A conical hill formed by the accumulation of cinders and other pyroclasts, normally of basaltic or andesitic composition.

CLASTIC - Pertaining to a rock or sediment composed principally of fragments derived from pre-existing rocks or minerals and transported some distance from their places or origin.

CLAY (soil) - A rock or mineral particle in the soil having a diameter less than 0.002 mm (*2 microns).

CLAY (geol) - a rock or mineral fragment or a detrital particle of any composition smaller than a fine silt grain, having a diameter less than 1/256 mm (4 microns).

COARSE-TEXTURED (light textured) SOIL - Sand or loamy sand.

CONFINED AQUIFER - An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself.

CONGLOMERATE - A coarse-grained sedimentary rock, composed of rounded pebbles, cobbles, and boulders, set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

CONSOLIDATION - Any process whereby loosely aggregated, soft, or liquid earth materials become firm and coherent rock; specifically the solidification of a magma to form an igneous rock or the lithification of loose sediment to form a sedimentary rock.

CONTAMINANT - As defined by Section 101(f)(33) of Superfund Amendments and Reauthorization Act of 1986 (SARA) shall include, but is not limited to any element, substance compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly be ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms of their offspring; except that the term "contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under:

(a) any substance designated pursuant to Section 311(b)(2)(A) of the Federal Water Pollution Control Act,

(b) any element, compound, mixture, solution, or substance designated pursuant to Section 102 of this Act,

(c) any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which under the Solid Waste Disposal Act has been suspended by Act of Congress),

(d) any toxic pollutant listed under Section 307(a) of the Federal Water Pollution Control Act,

(e) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and

(f) any imminently hazardous chemical substance or mixture with respect to which the administrator has taken action pursuant to Section 7 of the Toxic Substance Control Act;

and shall not include natural gas, liquified natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

CORAL REEF - A coral-algal or coral-dominated mound or ridge of in-place coral colonies and skeletal fragments, carbonate sand, and organically secreted calcium carbonate.

CRITICAL HABITAT - The specific areas within the geographical area occupied by the species on which are found those physical or biological features (1) essential to the conservation of the species, and (2) which may require special management consideration or protection.

DEPOSITS - Earth material of any type, either consolidated or unconsolidated, that has accumulated by some natural process or agent.

DIKE - A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks.

DRAINAGE CLASS (natural) - Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained - Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well-drained - Water is removed from the soil somewhat readily, but not rapidly. it is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textures. They are mainly free of mottling.

Moderately well drained - Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the soil, or periodically receive high rainfall or both.

Somewhat poorly drained - Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough periods during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very Poorly drained - Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

GLOSSARY OF TERMS (Continued)

DRAINAGEWAY - A channel of course along which water moves in draining an area.

DUST (volc) – A synonym of volcanic ash, especially the finer fractions of ash.

ENDANGERED SPECIES - Any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined by the secretary to constitute a pest whose protection would present an overwhelming and overriding risk to man.

EROSION - The general process or the group of processes whereby the materials of the earth's crust are loosened, dissolved, or worn away, and simultaneously moved from one place to another by natural agencies, but usually exclude mass wasting.

ERUPTION - The ejection of volcanic materials (lava, pyroclasts, and volcanic gases) onto the earth's surface, either from a central vent or from a fissure or group of fissures.

FAULT - A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

FELDSPAR - A group of abundant rock-forming minerals; the group is the most widespread of any mineral group and may constitute 60% of the earth's crust, occurring in all types of rock.

FINE-GRAINED - Said of a soil in which silt and/or clay predominate.

FINE-TEXTURED SOIL - Sandy clay, silty clay, and clay.

FLOOD PLAIN - That portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stage.

FOLD - A curve or bed of a planar structure such as rock strata, bedding planes, foliation or cleavage.

FORMATION - A lithologically distinctive, mappable body of rock.

FRACTURE (structural geology) - A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure be stress. Fracture includes crack, joints, and faults.

GABBRO - A group of dark-colored, basic intrusive igneous rocks composed principally of basic plagioclase: approximate intrusive equivalent of basalt.

GEOLOGIC TIME - See Figure GL.1.

GRABEN – An elongate, relatively depressed crustal unit or block that is bounded by faults on its long sides; it may also be known as a "rift valley."

GRAVEL - An unconsolidated, natural accumulation of rounded rock fragments resulting from erosion, consisting predominantly of particles larger than sand, such as boulders, cobbles, pebbles, granules or any combination of these fragments.

GROUNDWATER - Refers to the subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

GROUNDWATER DRAFT – Groundwater withdrawn from the subsurface.

HAZARDOUS MATERIAL - Any substance or mixture of substances having properties capable of producing adverse effects on the health and safety of the human being. Specific regulatory definitions also found in OSHA and DOT rules.

HAZARDOUS SUBSTANCE - CERCLA hazardous substances, pollutants, and contaminant as defined in CERCLA sections 101(14) and 101(33).

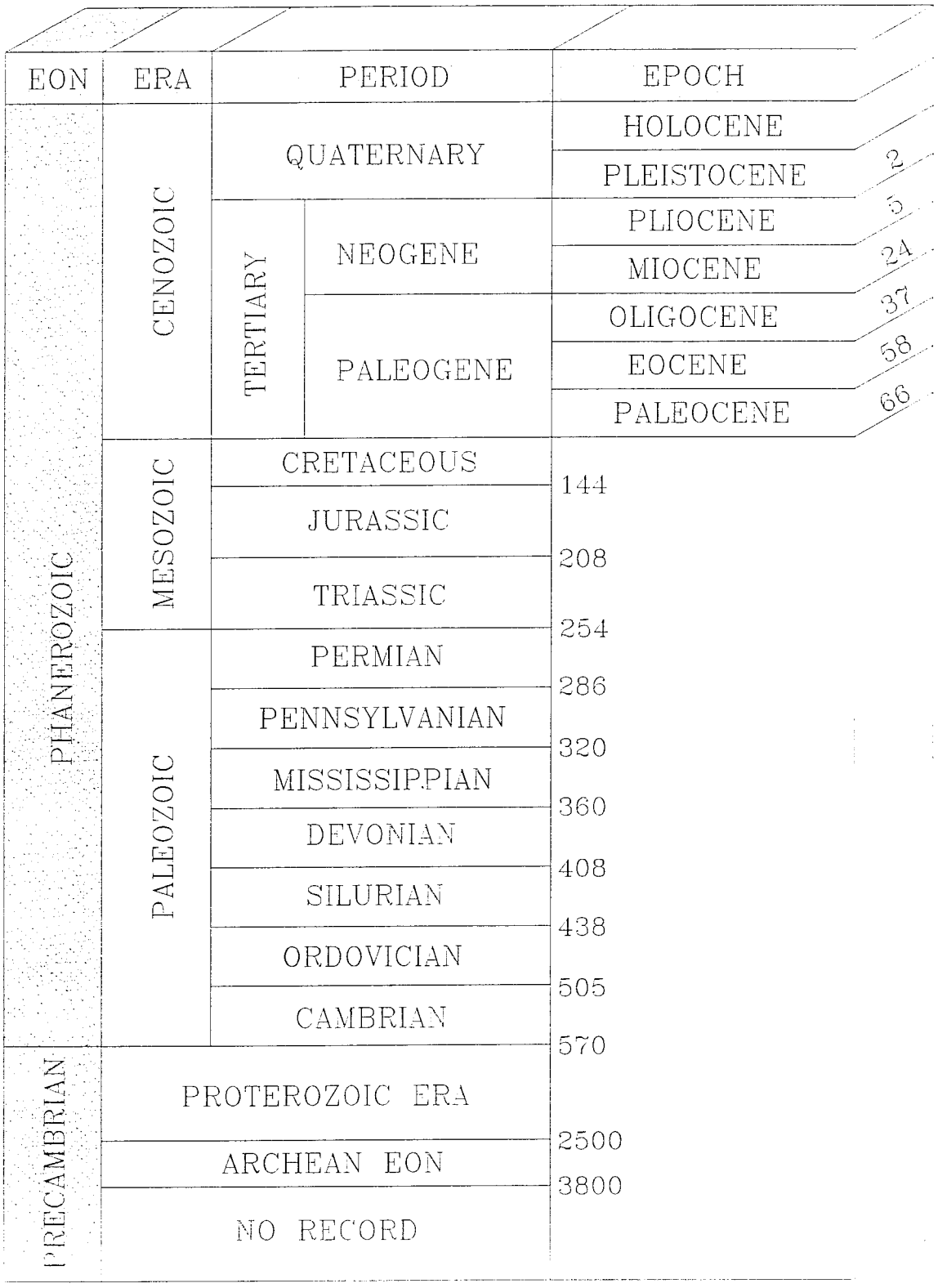
HAZARDOUS WASTE - A solid or liquid waste that, because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

HYDRAULIC CONDUCTIVITY – The capacity of a rock to transmit water.

IGNEOUS ROCKS - Rock or mineral that has solidified from molten or partially molten material; i.e., from magma.

INJECTION WELL - A well into which subsurface disposal of fluid or fluids occurs or is intended to occur by means of injection.

LAGOON – A shallow stretch of seawater, such as a sound, channel, bay, or saltwater lake, near or communicating with the sea and partly or completely separated from it by a low, narrow, elongate strip of such such as a reef, barrier island, sandbank, or spit, especially the sheet of water between an offshore coral reef and the mainland.



NOTE: NUMBERS ARE IN MILLIONS OF YEARS BEFORE THE PRESENT

FIGURE GL.1

KEKAHA TIMESCAL

THE GEOLOGICAL TIME SCALE

154th ACS, Kekaha Armory
Hawaii Air National Guard
Kekaha, Kauai, Hawaii

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

JANUARY 1995

LAVA - Fluid rock that issues from a volcano or fissure; also, the same material solidified by cooling.

LITHOLOGY - (a) The description of rocks. (b) The physical character of a rock.

LOWLAND - A general term for low-lying land or an extensive region of low land, especially near the coast and including the extended plains or country lying not far above tide level.

MAGMA - Naturally occurring molten rock material, generated within the earth and capable of intrusion and extrusion, from which igneous rocks have been derived through solidification and related processes.

MANTLE – The zone of Earth below the crust and above the core.

MARSH - A water-saturated, poorly drained area, intermittently or permanently water-covered, having aquatic and grasslike vegetation, essentially without the formation of peat.

METAMORPHIC ROCK - Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes in response to changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the earth's crust.

MIGRATION (Contaminant) - The movement of contaminants through pathways (groundwater, surface water, soil, and air).

OLIVINE - A common rock-forming mineral of basic, ultrabasic, and low-silica igneous rocks (gabbro, basalt, peridotite, dunite); it crystallizes early from a magma, weathers readily at the earth's surface, and metamorphoses to serpentine.

OUTCROP - That part of a geological formation or structure that appears at the surface of the earth; also, bedrock that is covered only by surficial deposits such as alluvium.

PAHOEHOE - A Hawaiian term for basaltic lava flows typified by a smooth, billowy, or ropy surface.

PERCHED GROUNDWATER - Unconfined groundwater separated from the underlying main body of groundwater by unsaturated rock.

PERMEABILITY - The capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment by the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

PHENOCRYSTS - One of the relatively large and ordinarily conspicuous crystals of the earliest generation in a porphyritic igneous rock.

PHREATIC EXPLOSION – A volcanic eruption or explosion of steam, mud, or other material that is not incandescent.

PHREATOMAGMATIC EXPLOSION – A volcanic explosion that extrudes both magmatic gases and steam; it is caused by the contact of magma with groundwater or shallow surface water.

POND - A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger than a pool.

POROSITY - The ratio of the aggregate volume of interstices in a rock or soil to its total volume.

PORPHYRITIC - A textural term for those igneous rocks in which larger crystals (phenocrysts or insets) are set in a finer groundmass which may be crystalline or glassy, or both.

POTENTIOMETRIC SURFACE - An imaginary surface representing the total head of groundwater and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

PYROCLAST – An individual particle ejected during a volcanic eruption.

RIFT ZONE - A system of crustal fractures and faults.

RIVER - A general term for a natural freshwater surface stream of considerable volume and a permanent or seasonal flow, moving in a defined channel toward a sea, lake, or another river.

ROCK – Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

RUNOFF - The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff.

SALINE (adj) - Salty; containing dissolved sodium chloride.

SAND - A rock or mineral particle in the soil, having a diameter in the range 0.52 - 2mm.

SEDIMENT - Solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice, or that accumulates by other natural agents, such as chemical precipitation from solution or secretion by organisms, and that forms in layers on the earth's surface at ordinary temperatures in a loose, unconsolidated form; (b) strictly solid material that has settled down from a state of suspension in a liquid.

SEDIMENTARY ROCK - A rock resulting from the consolidation of loose sediment that has accumulated in layers; e.g., a clastic rock (such as conglomerate or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice; or a chemical rock (such as rock salt or gypsum) formed by precipitation from solution; or an organic rock (such as certain limestones) consisting of the remains or secretions of plants and animals.

SEISMIC – Pertaining to an earthquake.

SILT (soil) - (a) A rock or mineral particle in the soil, having a diameter in the range 0.002-0.005 mm; (b) A soil containing more than 80% silt-sized particles, less than 12% clay, and less than 20% sand.

SITE - Area(s) where a hazardous substance has been deposited, stored, disposed, or placed, or has otherwise come to be located. Such areas may include multiple sources and may include areas between sources.

SOIL PERMEABILITY - The characteristics of the soil that enables water to move downward through the profile. Permeability is measured as the distance per unit time that water moves downward through the saturated soil.

Terms describing permeability are:

Very Slow -	less than 0.06 inches per hour (less than 4.24×10^{-5} cm/sec)
Slow -	0.06 to 0.20 inches per hour (4.24×10^{-5} to 1.41×10^{-4} cm/sec)
Moderately Slow -	0.20 to 0.63 inches per hour (1.41×10^{-4} to 4.45×10^{-4} cm/sec)
Moderate -	0.63 to 2.00 inches per hour (4.45×10^{-4} to 1.41×10^{-3} cm/sec)
Moderately Rapid -	2.00 to 6.00 inches per hour (1.41×10^{-3} to 4.24×10^{-3} cm/sec)
Rapid -	6.00 to 20.00 inches per hour (4.24×10^{-3} to 1.41×10^{-2} cm/sec)
Very Rapid -	more than 20.00 inches per hour (more than 1.41×10^{-2} cm/sec)

(Reference: U.S.D.A. Soil Conservation Service)

SOIL REACTION - The degree of acidity of alkalinity of a soil, expresses in pH values. A soil that tests of pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as:

Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 to higher

SOIL STRUCTURE - The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are - platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

SOLVENTS - A substance, generally a liquid, capable of dissolving other substances.

SOURCE - Any area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance. Sources do not include those volumes of air, groundwater, surface water, or surface water sediments that have become contaminated by migration, except: in the case of either a groundwater plume with no identified source or contaminated surface water sediments with no identified source, the plume may be considered a source.

STONE - A general term for rock that is used for construction, either crushed for use as aggregate or cut into shaped blocks as dimension stone.

STRATIFIED - Formed, arranged, or laid down on layers or strata; especially said of any layered sedimentary rock or deposit.

STRATIGRAPHIC UNIT - A body of strata recognized as a unit for description, mapping, or correlation.

STRUCTURAL - Of or pertaining to rock deformation or to features that result from it.

SURFACE WATER - All water exposed at the ground surface, including streams, rivers, ponds, and lakes.

SWALE - A slight depression, sometimes swampy, in the midst of generally level land.

SWAMP - An area intermittently or permanently covered with water, having shrubs and trees but essentially without the accumulation of peat.

THREATENED SPECIES - Any species which is likely to become an endangered species within the foreseeable future throughout all or significant portions of its range.

TIME (geologic) - See Figure Gl.1.

TOPOGRAPHY - The general conformation of a land surface, including its relief and the position of its natural and man-made features.

TSUNAMI - A great sea wave produced by a submarine earthquake or volcanic eruption (commonly and erroneously known as a "tidal wave").

TUFF – A general term for all consolidated pyroclastic rocks.

UNCONSOLIDATED - (a) Sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either on the surface or at depth. (b) Soil material that is in a loosely aggregated form.

UNDULATING (geomorph) - (a) A landform having a wavy outline or form. (b) A rippling or scalloped land surface, having a wavy outline or appearance.

VALLEY - Any low-lying land bordered by higher ground, especially an elongated, relatively large, gently sloping depression of the earth's surface, commonly situated between two mountains or between ranges of hills and mountains, and often containing a stream or river with an outlet. It is usually developed by stream or river erosion, but can be formed by faulting.

VEIN (intrusive rock) - A thin, sheetlike igneous intrusion into a fissure.

VESICLE - A small cavity in an aphanitic or glassy igneous rock, formed by the expansion of a bubble of gas or steam during the solidification of the rock.

VITRIC – Said of pyroclastic material that is characteristically glassy; i.e., contains more than 75% glass.

GLOSSARY OF TERMS (Concluded)

VOLCANO - A vent in the surface of the earth through which magma and associated gases and ash erupt; also, the form or structure, usually conical, that is produced by the ejected material.

WASTE DISPOSAL SYSTEM - An excavation in the ground receiving wastes which functions by allowing fluids to seep through its bottom, sides, or both, including cesspools, septic tanks, and seepage pits.

WATER TABLE - The upper limit of the portion of the ground that is wholly saturated with water; the surface on which the fluid pressure in the pores of a porous medium is exactly atmospheric.

WETLANDS - Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

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APPENDIX A

OUTSIDE AGENCIES CONTACTED

APPENDIX A

OUTSIDE AGENCIES CONTACTED

State of Hawaii
Department of Health
Environmental Management Division
Safe Drinking Water Branch
919 Ala Moana Boulevard
Honolulu, Hawaii 96813
(808) 586-4258

State of Hawaii
Department of Defense
Environmental Officer
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495
(808) 735-4659

State of Hawaii
Department of Defense
Office of the Adjutant General
Contracting & Engineering Officer
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495
(808) 735-3522

State of Hawaii
Department of Land and Natural Resources
Commission on Water Resource Management
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96809
(808) 587-0218

State of Hawaii
Office of Environmental Quality Control
Central Pacific Plaza
220 South King Street, 4th floor
Honolulu, Hawaii 96813
(808) 586-4185

OUTSIDE AGENCIES CONTACTED (Continued)

R. M. Towill Corporation
420 Waikamilo Road, Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133

Hawaii Air National Guard
Environmental Management Office
154th Civil Engineering Squadron
360 Harbor Drive
Hickam Air Force Base, Hawaii 96853-5517
(808) 449-5711

Agency Information Consultants
1708 Guadalupe
Austin, Texas 78701
(512) 478-8991

State of Hawaii Archives
Iolani Palace Grounds
Honolulu, Hawaii
(808) 586-0329

U. S. Army Corps of Engineers
Pacific Ocean Division
Honolulu District
Fort Shafter, Hawaii 96858
(808) 438-1331

U.S. Department of Agriculture
Soil Conservation Service
Prince Kuhio Federal Building
Honolulu, Hawaii
(808) 541-2600

U.S. Fish and Wildlife
Pacific Islands Office
P. O. Box 50167
Honolulu, Hawaii 96850
(808) 541-2749

OUTSIDE AGENCIES CONTACTED (Concluded)

National Oceanic & Atmospheric Administration (NOAA)
National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii 96822-2396
(808) 943-1221

Hawaii Army National Guard
Fort Ruger, Hawaii
(808) 732-1574

U.S. Department of the Interior
U.S. Geological Survey
Branch of Distribution
Box 25286
Denver Federal Center, Bldg 810
Denver, CO 80225

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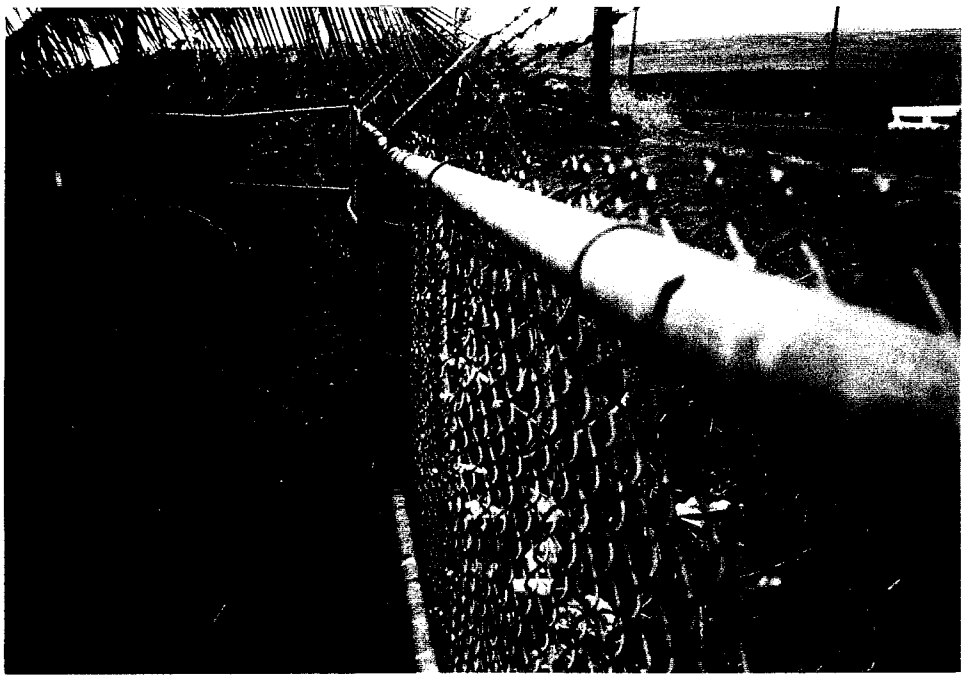
APPENDIX B

PHOTOGRAPHS

1. View showing front (south side) of Armory Building.



2. View showing Armory south and east fence lines and elevation in relation to Kekaha Road.

3. View, looking east, showing equipment storage area at rear (north) of Armory Building and along the east fence line.

4. View showing peeling paint on side of Armory Building.